Facility Plan

MWWTP Solids Processing Improvement Project

Project No. 970300

Prepared for

Metropolitan Council Environmental Services

December 1998

Prepared by

CH2MHILL

In association with

Earth Tech, Inc.

RCM Associates, Inc.

Richardson, Richter and Associates, Inc.

Environmental Financial Group, Inc.

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I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of Minnesota.

David L. Raby

Date 12/22/98 Registration No. 24978

Table of Contents

List of Tables

List of Figures

Acknowledgements

Development of this Facility Plan was a collaborative effort of many people in MCES and their consulting project team. An MCES core team led the project along with seven employee task forces. The dedicated effort of all individuals to prepare the Facility Plan is acknowledged with great appreciation.

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• **CH2M HILL, Inc.**	**Lead Consultant**
• Rust Environment and Infrastructure	Environmental Permitting
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• Richardson, Richter and Associates, Inc.	Communications
• Environmental Financial Group, Inc.	Economics and Finance
• 106 Group, Inc.	Archaeological Investigations
• Kaempfer and Associates, Inc.	Engineering
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• Carlson Associates, Inc.	Air Pollution Control Systems and Incineration

The Public

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Section 1
Executive Summary

Overview

This Facility Plan describes the Solids Processing Improvement Project ("Project") and technologies selected for upgrading the solids processing facilities at the Metropolitan Council's largest wastewater treatment plant (Metro Plant). The alternatives evaluated and the technology selected to process solids to the year 2025 are presented in the following sections.

Following extensive evaluation, this Facility Plan recommends replacing the existing multiple hearth incinerators with an energy recovery system consisting of fluid bed incinerators (FBIs) in combination with an alkaline stabilization system for long-term solids management at the Metro Plant.

Metropolitan Council Environmental Service (MCES), the wastewater conveyance and treatment division of the Council, completed an evaluation of its existing facilities at the Metro Plant prior to initiating this Facility Plan. The evaluation culminated in a Metro Plant Master Plan (December 1996), adopted by Council, which concluded that solids processing facilities should receive high priority for replacement to control increasing maintenance costs, reduce odors, and enhance the Metro Plant's ability to meet environmental requirements. This Facility Plan includes an evaluation of six solids stabilization alternatives that were considered for the Project.

Reduction of odors has been a long-standing goal of MCES as part of its "good neighbor" policies. Neighbors surrounding the plant, particularly the Dayton's Bluff community in St. Paul, have expressed concerns and registered complaints about odors from the Metro Plant for a number of years. Controlling odors was a significant criterion when selecting the preferred technology for the Project.

Reducing operating costs at the Metro Plant has been a continuous process for MCES. Superior maintenance at the plant has enabled MCES to obtain the maximum life from equipment and structures. However, continuing to maintain outdated equipment has led to increased operations and maintenance (O&M) costs, and does not provide the environmental benefits of new technology.

The existing solids processing equipment includes more than the multiple hearth incinerators. The process begins with thermal conditioning of the solids in a Zimpro™ heat treatment process. Solids from the Zimpro™ process are then "dewatered" through centrifuges, vacuum filters, and roll presses. In the past, liquid from the Zimpro™ process was treated in a special side-stream treatment process designed to handle high strength waste. The side-stream treatment process has recently been decommissioned due to high maintenance and odor emissions, and high strength liquid from the Zimpro™ process is now sent directly to the primary treatment process. Four of the current multiple hearth incinerators were installed in the mid-1960s and two were installed around 1980, with the other four being rehabilitated. When these incinerators are replaced in 2004, they will be approaching the end of their design life. When considering maintenance of the entire equipment system including pre-treatment, incineration, dewatering, and air pollution control, the optimum choice is to replace the existing solids processing facilities.

The Metro Plant has had difficulty in achieving federal and state environmental requirements due to the current facility's outdated technology and need for modification to the existing incinerators. The Master Plan evaluation of alternatives confirmed significant opportunities to reduce emissions from the plant through replacement of the existing solids processing facilities.

Background

The Metro Plant is the largest of the nine wastewater treatment plants owned by MCES. It serves a population of approximately 1.7 million people and 20 major industries, with a loading to the plant equivalent to approximately 500,000 people. The solids processed at the Metro Plant represent about 80 percent of the total solids treated by MCES. In 1997, the annual average daily flow treated at the plant was 225 million gallons per day (mgd). By the year 2005, this flow is projected to be 234 mgd; by the end of the planning year for this plan (2025), the flow to the plant is projected to be 261 mgd. The corresponding solids quantities to be processed are 265 dry tons per day (dtpd) in 2005 and 299 dtpd in 2025.

Recommendation

This Facility Plan recommends replacing the existing incinerators with three new FBIs and state of the art energy recovery and air pollution control equipment, coupled with an alkaline stabilization system for producing biosolids for agriculture.

Three FBIs will process the average annual loading of solids, while an alkaline stabilization system will handle peak loads and loads during incinerator maintenance or unexpected shut down. The use of high solids centrifuges to produce a dewatered solids cake prior to incineration will allow the current heat treatment system and dewatering process to be permanently decommissioned. The three FBIs and alkaline stabilization process will have design capacities of 315 dtpd and 188 dtpd, respectively. The alkaline stabilization system will operate primarily during FBI downtime for maintenance and during peak solids loading; however, MCES may operate the system more frequently at their discretion. A maximum of approximately 10,000 dry tons of alkaline stabilized product will be produced in 2005.

An Environmental Assessment Worksheet is being prepared for the recommended plan on a voluntary basis by MCES.

Alternatives Evaluated

During the Metro Plant Master Plan process, 12 solids processing alternatives (five basic technologies) were evaluated. Although fluid bed incineration was recommended for further study, MCES directed the first phases of the Facility Plan development to include an evaluation of both heat drying technologies and FBI technologies. Evaluations of these alternatives are presented in Section 6. After consideration of non-monetary and monetary criteria and extensive public outreach, the three FBI recommendation was reached. Non-monetary criteria included: emissions, residuals (recycling organics to land), odors, and energy (reliance on fossil fuels). Monetary criteria included capital and operating cost, and total life cycle cost.

Following this evaluation of alternatives, MCES staff recommended that the Council incinerate solids and scheduled a public hearing on the recommendation.

When the recommendation was considered at the public hearing, various citizens and groups expressed concern and requested additional evaluation of more land application alternatives. As a result of these comments, MCES evaluated full-scale alkaline stabilization and anaerobic digestion. As presented in Section 6, these alternatives were developed to the same level of detail as the heat drying and FBI options. Information was shared with the public and discussions continued for several months. The Metropolitan Council extended the selection of a preferred technology from April until the end of July 1998. This resulted in public review and comment on six alternatives developed for this Facility Plan.

These additional alternatives had a greater life cycle cost than the recommended alternative, and did not create significant advantages regarding non-monetary considerations.

Following the public input, the Metropolitan Council concluded, on July 23, that the preferred alternative will be three FBIs in combination with an alkaline stabilization system.

The Energy Recovery System

The three FBIs will operate without the use of supplemental fuel to burn the sewage solids, except for the initial heating required to start the incinerators. Sewage solids contain sufficient BTUs to burn without supplemental fuel when dewatered to 30 percent dry solids, and will provide excess energy for facility heating and electricity production. This reduces the Metro Plant's current energy consumption.

Supplemental Land Application

The biosolids product from the alkaline stabilization system is estimated to be a maximum of 10 percent of the Metro Plant total solids production. It will be applied to agricultural land as a soil amendment.

Other land application technologies that could be coupled with the three FBIs were evaluated and found not practicable for a number of reasons. Other alternatives included heat drying, anaerobic digestion, and composting.

Odor

Odors and odor sources will be substantially reduced with the recommended plan. Decommissioning the Zimpro™ heat treatment process will eliminate one of the most dominant sources of odors currently produced at the plant. All new facilities will be contained, and process air will be incinerated or treated to eliminate odors from solids processing facilities. The alkaline stabilization process and storage areas will be contained within buildings with odor control facilities.

Air Emissions

Air emissions from the FBIs will be controlled through a system of air pollution control equipment designed to remove greater than 99 percent of all particulate matter. The air pollution control system does not need to control oxides of nitrogen and carbon monoxide. These pollutants are controlled through uniform combustion temperatures and good air mixing inherent in the FBI technology.

The air pollution control system will be designed to achieve 70 percent mercury removal. This is in addition to a pollution prevention program MCES initiated to prevent the entry of mercury into the wastewater stream. Provisions will be designed into the air pollution control system to allow installation of additional mercury control equipment in the future.

Particulate emissions from the alkaline stabilization storage facilities will be controlled using a cartridge air filtration system.

Location

The new facilities will be located in the northeast corner of the existing plant site, inside the surrounding levee. This area is the least likely area for future expansion of liquid line facilities. Initial cultural resource evaluations at this site indicate a slight potential for finding Native American artifacts. Additional investigations have been recommended and are being conducted in anticipation of future construction at the site. No construction delays or archaeological issues are expected.

Alternative sites such as the existing incinerator building and the abandoned incinerator building were evaluated and found to be more costly and impractical.

Instrumentation and Control

A new plant-wide instrumentation and control system is being installed at the Metro Plant. This same system should be extended to serve the recommended solids processing facility.

Market Analyses of Biosolids and Ash Recycling

Market analyses of biosolids from heat drying and incinerator ash were conducted to estimate revenue and cost for each. The biosolids market analysis was prepared by Vital Cycle, a broker company for biosolids products in the United States. Vital Cycle concluded that an agricultural market for heat dried biosolids could be developed in the region (within 60 miles), and that a net (customer price less application, freight, and marketing costs) of $5.00/dt could be expected from marketing a low quality dried product, and $7.83/dt from marketing a high quality dried product. Up to 4 years would be needed to build a market for the amount of biosolids produced at the Metro Plant. An economic sensitivity test was also conducted to assess the effect of a range of revenues and costs for biosolids marketing. This assessment showed that biosolids revenues and costs had little impact on the total cost for the alternatives.

A separate study of ash utilization was prepared to determine the viability of the market for incinerator ash. MCES currently manages their incinerator ash through a contract with a hauler who delivers the ash to Mason City, Iowa, for use in concrete products. The cost of recycling ash to concrete products is currently \$53.00/ton. The market analysis found that this cost is likely to decrease as haul contracts become more competitive and the options for use of ash in construction products (such as highway asphalt) expands. Regardless of this projection, a cost of \$53.00/ton was used to calculate the operating cost of the energy recovery options.

Cost

As presented in Section 6, the three FBIs with alkaline stabilization alternative has a total capital cost estimate of \$189 million in 1998 dollars. The life cycle cost or present worth of capital and operating costs over a 20-year period for the this alternative is \$283 million.

Capital cost estimates were developed on a comparable level of detail for all alternatives evaluated. The estimates represent an advanced master plan level of detail, but not an engineered plans and specifications level of detail. All estimates in the comparative analysis presented in Section 6 include a 25 percent contingency for engineering, administration, and legal costs, and a 25 percent contingency for undefined details. The refined capital cost estimate of the recommended alternative uses different contingencies, as detailed in Section 3.

In the comparative analysis presented in Section 6, the capital costs of the alternatives evaluated were all 12 to 28 percent higher than the cost of the three FBIs with alkaline stabilization alternative. The present worth of the alternatives evaluated, including revenue from biosolids, were 6 to 19 percent greater than the three FBIs with alkaline stabilization alternative.

Public Participation

Public participation from all interested stakeholders was encouraged throughout the facility-planning phase. Educating stakeholders about the need for a new solids processing facility as well as the benefits of a new facility was the first public communications goal. Various communication tools were used with internal and external stakeholders during the first 6 months of the facility planning process. Following this initial public participation, MCES staff continued to work closely with concerned citizens. From April through July 1998, numerous meetings, a public hearing, and a public workshop were held with stakeholder groups. MCES will continue to work with all interested citizens and groups throughout the planning, design, and construction of the Project.

Preparation for Next Steps

There are several approaches to the design, construction, and operation of the recommended facilities. As part of this Facility Plan development, a task force comprised of MCES staff from various workgroups was formed to evaluate applicable options and recommend the best project delivery option to achieve a cost-competitive, technically sound solids processing facility.

Project Delivery

Four major options were evaluated:

1. Design/Bid/Build, plus operations
2. Design/Build, plus operations
3. Design/Build/Operate
4. Design/Build/Own/Operate

The evaluation of these options included assistance from an expert panel of utility managers with experience implementing one or more of these alternatives. Fourteen criteria were used to rank each of the options in order to make a recommendation.

The recommended general approach for delivery of this project is a Design/Bid/Build approach coupled with development of an "Internal Contract" for operations by MCES staff. As a way of establishing a cost-competitive internal operations contract, it is recommended that a benchmark study on operation of facilities similar to the facilities recommended in this plan be developed. The benchmarking process would be used by MCES to determine its operating cost goal and to identify methods to more efficiently operate and maintain the plant. Design is scheduled to commence in 1999, followed by construction in 2000 and facility commissioning in 2003 and 2004.

Permitting

An application for an air pollution control operating permit will be submitted to the Minnesota Pollution Control Agency (MPCA) in October 1998. Due to the lower emission characteristics of the FBI and alkaline stabilization system, the applicant (MCES) will be able to show a net reduction in total emission of pollutants of concern over current emissions. As a result, the project will not be subject to review under Prevention of Significant Deterioration and New Source Review (PSD/NSR) regulations. MPCA is expected to act on the MCES application by June 1999. This is in sufficient time for the solids facilities to meet a 2004 on-line goal.

Conclusions

The Solids Processing Improvement Project, as detailed in this Facility Plan, will serve the environmental and economic interest of the Minneapolis/St. Paul citizens well into the 21st century. It is first and foremost a prudent Project for energy management. It has the lowest use of fossil fuel among the alternatives evaluated and relies primarily on the BTU value of the wastewater solids to stabilize and destroy all viruses and pathogens in the solids. Additionally, the Project achieves the International Kyoto Protocol's goal of reducing greenhouse gas emissions, and is more sustainable than those alternatives dependent upon natural gas fuel to stabilize the sewage solids. The recycling of incinerator ash to concrete products maintains the MCES goal of recycling waste products.

Development of an agricultural and horticultural biosolids is realized with the recommended Project. Up to 10 percent of the Metro Plant solids loading will be processed to produce biosolids for agriculture. Not only does this continue the Council's long-standing role in biosolids production, but also provides a unique way to avoid higher capital costs to process peak solids quantities. This FBI system in conjunction with alkaline stabilization is a good environmental and economic marriage.

The recommended Project achieves significant reductions in emissions of pollutants of concern.

The Project provides a significant decrease in odor sources and the most reliable control technology for odors that remain to be controlled. It will fulfill promises to the neighbors to substantially reduce odors.

The Project as described in this Facility Plan fits the environmental and economic goals of the Metropolitan Council, and best serves the citizens of the Minneapolis/St. Paul metropolitan area.

Section 2
Introduction

Purpose

This Facility Plan has been prepared as a decision document for the Metro Plant Solids Processing Improvement Project (Project Number 970300). The purpose of the Plan is to define and evaluate solids processing alternatives for the Metro Plant and recommend a preferred alternative for final design and implementation. When approved by the Metropolitan Council, the Facility Plan will be the basis for commencing final design and implementation of solids processing improvements at the Metro Plant, and for requesting funding from the Minnesota Pollution Control Agency.

Scope

Preparation of the Plan involved a planning process that began in mid-1997. The initial scope of the planning process involved the evaluation of two alternative technologies for solids stabilization at the Metro Plant: (1) heat drying to produce a product for use in agriculture and horticulture and (2) fluid bed incineration with heat recovery and recycling of ash in building products. These alternatives were developed in the Metro Plant Master Plan (December 1996), prepared by the Metropolitan Council Environmental Services (MCES), and were selected for further evaluation during this facility planning process. Over the course of the planning process, this scope was expanded to include the evaluation of four basic alternative technologies for final solids stabilization. Overall, the Facility Plan scope includes:

1. Evaluate and compare the monetary and non-monetary attributes of fluid bed incineration and heat drying technologies
2. Evaluate the potential to create a market and generate revenue from a heat dried biosolids soil amendment product
3. Evaluate and recommend a site within the Metro Plant for final solids processing facilities
4. Prepare environmental permit applications, particularly an application for an air emissions permit major amendment
5. Complete engineering necessary to support environmental permit application documents
6. Recommend a final solids processing stabilization technology and facility for the Metro Plant

7. Complete initial plan level design and cost estimate for the recommended alternative

8. Evaluate and recommend an approach for the delivery (design and construction) of the solids processing facilities

9. Prepare environmental assessment worksheets for the preferred alternative

10. Develop a public education and involvement program

In developing the plan a number of key assumptions or "Terms of Reference" are used to maintain consistency for comparison among alternatives. These Terms of Reference are as follows:

1. Planning period is from 2005 to 2025

2. All facilities are to be located within the dike system surrounding the Metro Plant

3. Monetary and non-monetary factors are to be considered in making a technology recommendation

4. Discount rate for life-cycle cost analysis is 6 percent

5. Life-cycle costs are based on 20-year term

6. Solids dewatering equipment is included in this plan, with equipment selection to be completed through MCES solids dewatering equipment-testing project

7. Solids quantities are those developed as part of MWWTP Preliminary/Primary Improvement Project

8. The 'unit processes' included in the Solids Processing Improvement Project start with the delivery of thickened primary and secondary solids through the delivery of the final product for recycling

Alternatives Evaluated

This Facility Plan evaluates four of the five basic stabilization technologies considered in the Metro Plant Master Plan for final solids processing. The four stabilization alternatives include heat drying, incineration, anaerobic digestion, and alkaline stabilization. Composting was not evaluated because of space, climate, and odor considerations. The four basic stabilization technologies were developed into six solids processing alternatives presented in Section 6 of this Facility Plan.

Organization of the Plan

This Facility Plan is organized into 12 sections. Each section presents information relevant to the development of the recommended alternative presented in Section 3 of the Plan. The evaluation and comparison of the six solids processing alternatives are included in Section 6 of the plan.

The recommended alternative in Section 3 was developed through an evaluation of monetary and non-monetary factors leading to the Metropolitan Council's selection of a preferred technology. The preferred technology is a 'hybrid technology' representing a combination of three fluid bed incinerators (FBIs) as the primary solids processing technology with alkaline stabilization as the supplemental solids processing technology.

The Council's decision to select this hybrid solids processing technology occurred on July 23, 1998, following staff recommendation, a public hearing, public workshop, and additional comment by interested citizens. In developing the recommended alternative, Council directed staff to evaluate a number of land application alternatives for supplemental solids processing. This resulted in the recommended use of alkaline stabilization to supplement the three FBIs.

A potential project implementation schedule is included in Section 4. Final design will refine the plans and specifications from which a detailed design, bid, and construction schedule can be developed. Implementation is expected to be approximately 4 years, depending upon design decisions, permits, and authorizations. There will be many business decisions regarding contract packaging, equipment procurement, and construction management during the design process. Initial sequence of implementation and a schedule have been developed and are included in Section 4.

Cost Estimates

Each alternative was developed using the same terms of reference and level of detail for cost estimates. Following the Council's selection of the preferred technology, a refined cost estimate was prepared for the recommended alternative using more detailed engineering and vendor quotes. A refined estimate for the recommended plan is included only in Section 3 of the Facility Plan.

The refined estimate is within the estimating range of the costs developed for comparison of the alternatives in Section 6, providing confidence that the estimating methods are suitable for making plan level decisions.

Projected Solids Quantities

The solids processing alternatives in Section 6 were developed using projected solids quantities from the Metro Plant Master Plan (December 1996). Revised projected solids quantities were prepared as part of the MWWTP Preliminary/Primary Improvement Project. These revised solids quantities were used to refine the recommended solids processing alternative presented in Section 3. The revised estimates are not significantly different from the Metro Plant Master Plan estimates.

Environmental Factors

Environmental factors are presented in Sections 6 and 11 of this Facility Plan. Monetary and non-monetary factors were included in the evaluation of alternative solids processing technologies. While many of the non-monetary factors involve making subjective judgements, many factors such as pollutant emissions, odor sources, and fossil fuel consumption are quite measurable. In consideration of both measurable and non-quantifiable factors, the relative advantage of each alternative was assessed and is presented in Section 6.

Project Delivery Options

The recommended approach for delivery of the project is included in Section 12. "Delivery of the project" means the approaches or combination of approaches that can be used to design, procure, construct, own and/or operate the facility. Many different approaches to the delivery of major public works are possible to manage risk, reduce cost, and shorten time required to deliver projects from design through operation. Each approach has different advantages and disadvantages depending upon the nature of the project. Section 12 presents the evaluation of these strengths for this project and recommends a design, bid, and build delivery approach.

Public Involvement

An overview of public participation efforts the Council and its staff participated in with external and internal stakeholders is included in Section 10. In addition to many meetings, open houses, and mailings, the Council held a public hearing on the staff's technology recommendation. This section provides a summary of major concerns raised by the public in eight specific areas including Clean Air Act emissions, mercury control, greenhouse gas emissions, odor control, sustainable development, market and economic assumptions, energy efficiency, and environmental review.

Section 3
Recommended Alternative

Overview

This Facility Plan recommends replacing the existing multiple hearth incinerators with three new fluid bed incinerators (FBIs) coupled with an alkaline stabilization system for solids processing improvements at the Metro Plant.

The Environment Committee recommended and the Metropolitan Council approved selection of a primary solids stabilization technology consisting of FBIs, including energy recovery, supplemented with alkaline stabilization that produces biosolids for application to agricultural land. The FBI process is the lead process with maximum processing capacity of 315 dry tons per day (dtpd). The alkaline stabilization process will have sufficient capacity to stabilize the solids loadings which exceed the capacity of the fluid bed incineration system during peak loadings and when one FBI is removed from service. On an annual basis, it is anticipated that the FBIs will stabilize 90 percent of the Metro Plant's wastewater solids. Energy recovery is accomplished by using the excess heat from the FBI process to generate electricity and heat Metro Plant Buildings.

Operationally, the Metro Plant is continuously receiving and successfully treating wastewater in compliance with permit requirements. This results in the continuous production of unstabilized wastewater solids and the need for on-line solids processing facilities.

This section contains a description of the recommended on-line solids processing facilities including sizing criteria, site plan, flow schematic, and costs

Recommended Solids Processing Facilities

Recommended wastewater solids processing facilities addressed within this Facility Plan are to handle the thickened primary solids, thickened waste activated solids, and dilute primary scum. Upstream solids thickening facilities are being incorporated in the Metro Plant Liquids Facility Plan.

Solids Facility Overview

Wastewater solid residuals from primary sedimentation, and waste activated solids from the secondary treatment process are continually produced in large quantities at the Metro Plant. Projected solids quantities are included in Section 9 – Flows and Loads.

These projected solids quantities must be stabilized on a continuous basis to 1) reduce the health risk should humans or animals come in contact with the solids; 2) protect the environment; and 3) eliminate the emission of objectionable odors within and outside of the Metro Plant. Energy recovery consisting of FBIs with heat recovery is the recommended primary technology at the Metro Plant. The alkaline stabilization process is recommended as a supplemental process to FBIs to stabilize the wastewater solids that exceed the capacity of the FBI system and to produce a biosolids product suitable for agricultural application. These processes will achieve the primary goals of public health protection, environment protection, and the control of objectionable odors. A process flow schematic of the recommended Metro Plant solids processing facilities is shown on Figure 3-1.

Storage/equalization, screening, and dewatering of wastewater solids will precede the FBI and alkaline stabilization processes. Storage/equalization functions to provide consistent solids characteristics for the downstream processes including dewatering. Screening removes debris from the solids stream, protects downstream equipment, and eliminates unacceptable materials in the biosolids. Effective dewatering reduces the operational costs, improves energy recovery and the handling characteristics of the alkaline stabilization product.

The FBIs will process approximately 90 percent of the dewatered solids. The residual wastewater solids not incinerated will be mixed with alkaline materials to raise the pH and temperature of the mixture to levels that achieve EPA criteria for agricultural application of the biosolids. Since, the elevated pH releases odorous ammonia in objectionable concentrations, the production and storage areas of the alkaline material must be enclosed. Ammonia gases can then be captured, converted to a liquid solution, and returned to the liquid treatment process.

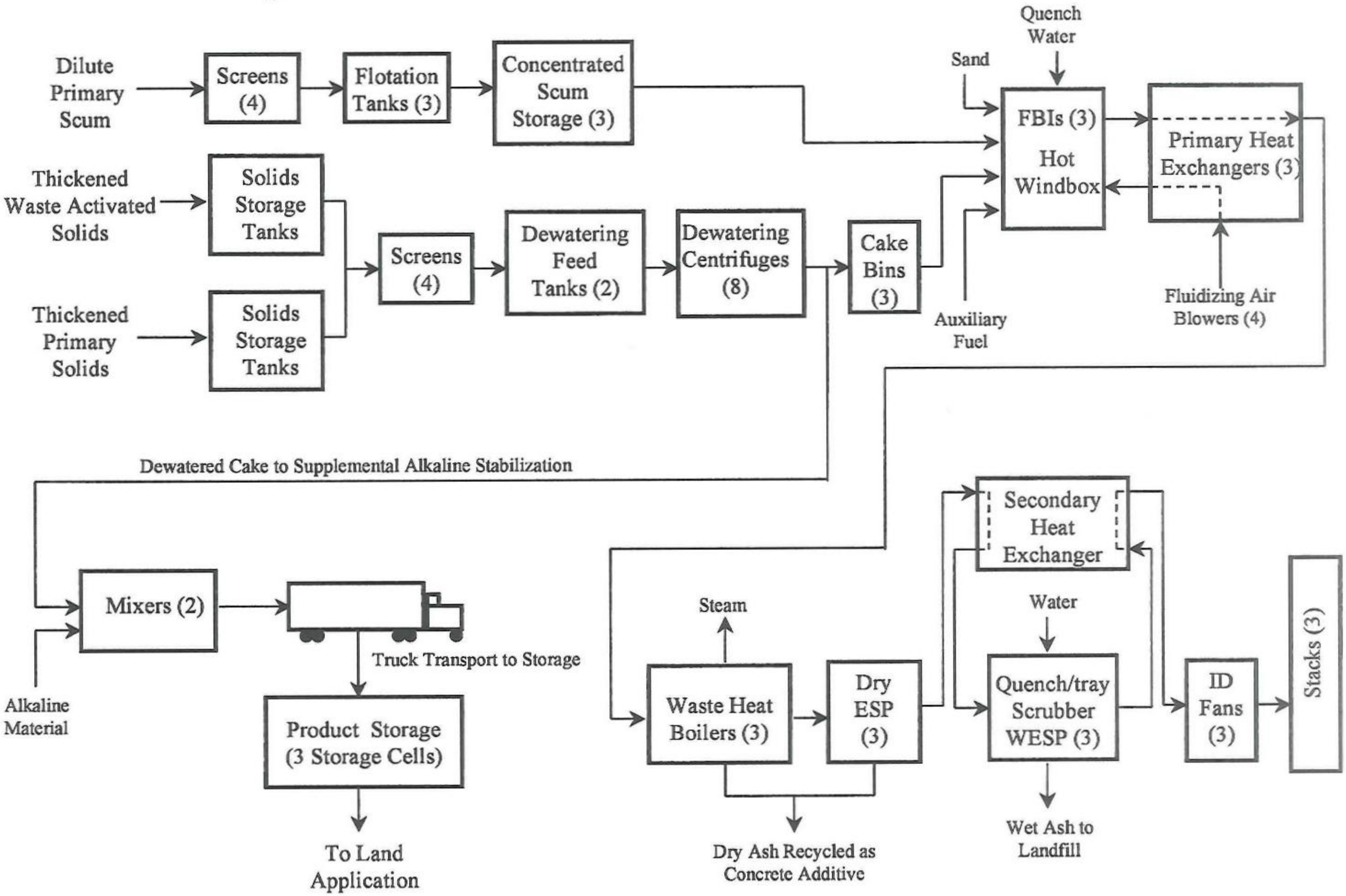
Heat and ash are the residuals from the FBIs and air pollution control equipment. Recovered heat will be converted into steam to heat Metro Plant Buildings and to generate electricity. Dry ash collected in the heat recovery facilities and dry pollution control equipment will be marketed as a concrete additive. Minor amounts of wet ash collected from the wet pollution control equipment will be dewatered and land filled, or returned to the liquid treatment facilities. Biosolids from the alkaline stabilization process will be stored until they can be applied to agricultural land.

Storage of Thickened Wastewater Solids

Thickened primary and waste activated solids streams are pumped to one of eight existing solids storage tanks. Each tank has a functional capacity of 700,000 gallons. Thickened solids will be stored in the existing solids storage tanks as required to feed the dewatering process with a uniform solids stream. Under normal operations, a minimum of four solids storage tanks will be reserved for emergency storage. Stored solids will be mixed with air to reduce the potential release of phosphorus from the cells of the waste activated solids organisms.

Solids will be continuously pumped from the solids storage tanks to one of two dewatering feed tanks located in the new Solids Management Building.

Figure 3-1
Solids Processing Schematic



Solids Dewatering

Wastewater solids consisting of primary scum, primary solids, and waste activated solids include water and other debris such as grit, rags, plastics, and paper. The primary objective of the dewatering process is to reduce the water content using physical processes versus thermal technology. Physical processes include screening, flotation, and centrifugal force.

Scum Dewatering/ Screening

Dilute primary scum will be collected from the surface of the primary clarifiers and conveyed to the new Solids Management Building as a dilute liquid stream of up to 960 gallons per minute (gpm). This raw scum consists of oil, grease, rags, plastics, wood, water and any debris that will float. The scum is first screened to remove the debris such as rags from interfering with subsequent processes. Following screening, the dilute scum is passed through one of three flotation tanks where the oil and grease is removed from the surface with a small amount of water. This flotation process essentially removes over 99 percent of the water. Collected oil and grease are heated, stored, and then pumped to the FBIs at rates of 30 gallons per hour (gph) or less. The debris separated from the dilute scum will be combined with the dewatered solids in the FBI feed bins.

Solids Dewatering

Thickened primary and waste activated solids will be continuously pumped from the solids storage tanks to two dewatering feed tanks in the new Solids Management Building. Before being discharged into the feed tanks, the solids will be screened to remove debris that could interfere with the operation of the dewatering equipment or be visually unacceptable in the biosolids. Debris removed from the solids will be re-combined with the dewatered solids before being introduced into the FBIs, but not the alkaline stabilization system.

The equalized and screened solids streams will be pumped from the dewatering feed tanks to the high solids dewatering centrifuges which increase the solids concentration from 5 percent to approximately 30 percent.

To aid in the dewatering process, a dilute polymer solution will be added to the solids stream before being dewatered in the centrifuges. Polymers facilitate the separation of water from the solids mass in the dewatering process. Polymer requirements based on 1 year of operational testing are projected to average 8 pounds per dry ton of solids fed to the dewatering process. Dry and liquid polymer storage and feed facilities will be included.

The number of operating dewatering centrifuges will depend upon the quantity and characteristics of the solids stream. Nominal hydraulic capacity of a centrifuge is 220 gpm of a solids stream containing 5 percent dry solids. At peak loading conditions, six or more centrifuges may be required. Therefore, with an allowance for maintenance, eight dewatering centrifuges will be included.

Solids Stabilization

Two processes will be included for the stabilization of the Metro Plant's wastewater solids. Energy recovery is the lead process and consists of three parallel trains of FBIs followed by heat recovery and air pollution control equipment. The second stabilization process includes blending alkaline materials with the dewatered solids to produce a suitable material for agricultural application. Alkaline stabilization provides low capital cost capacity to stabilize peak solids loadings and provide backup capacity should a FBI be removed from service.

Energy Recovery

Energy recovery captures heat from the combustion of dewatered wastewater solids. Key components of the energy recovery process are solids feed, fluid bed incinerator, heat recovery, air pollution control equipment, and ash handling systems.

Solids Feed

Dewatered solids, referred to as dewatered cake, will discharge from the bottom of the centrifuge enclosure into horizontal conveyors. The conveyors transfer the dewatered cake to one of three storage bins. Debris removed from the dilute primary scum and primary solids streams will recombine with the dewatered cake solids in one of the three cake bins. This mixture of dewatered cake and scum/solids screenings will be pumped into the FBIs at near constant rates to stabilize the combustion process. Six cake pumps designed for pumping solids material are included for this function. Each cake pump has sufficient capacity to feed a FBI at design loadings of 105 dtpd. As a result, there is a lead and backup cake pump to feed each FBI.

Fluid Bed Incinerators

Three FBIs will be included. While operating at design conditions, the FBIs will sustain combustion without the addition of supplemental fuel.

Wastewater solids have a fuel value; each pound of volatile solids has a heat value of approximately 10,000 BTUs. Typically, 77 percent of the Metro Plant's wastewater solids are volatile solids. In addition, primary scum has a heat value of 18,000 BTUs per pound of scum, excluding all water. Based on these heat values and projected annual average solids quantities for year 2005, the total heat value of the feed solids is 172 million BTUs per hour. The projected associated water load at 30 percent dry solids will require approximately 90 million BTUs per hour for water evaporation. Consequently, the fuel in wastewater solids and primary scum has sufficient energy for sustainable combustion and the recovery of some surplus heat.

Each FBI reactor has the following three elements all housed in a steel shell with refractory lining:

- Hot wind box
- Bed zone
- Free board zone

At the base of the unit where the hot wind box is located, the FBI is approximately 20 feet in diameter. At the top of the unit in the free board zone, the diameter including the refractory lining is approximately 32 feet. Each FBI is sized to incinerate 105 dtpd at design conditions of 30 percent dry solids in the cake and with a volatile fraction of 77 percent.

Hot air is introduced into the hot wind box and passes vertically through the refractory-lined bed supporting structure through tuyeres, which are designed for air passage without significant reverse flow of bed materials when the unit is shut down. Vertical air velocity within the bed zone fluidizes the bed contents consisting of sand and the feed solids. Combustion of the solids occurs within the bed zone as the sand is maintained at a temperature of approximately 1,450 to 1,500° F. Vaporized organics are combusted in the free board zone where the temperature within the FBI is approximately 1,500 to 1,550° F before exiting the top of the FBI. If insufficient heat is available to support the combustion process, heat is added in the bed zone of the FBI by injecting natural gas or fuel oil. If the FBI temperature is too high, the feed rates of solids can be reduced, air supply can be marginally increased, and/or water can be sprayed into the FBI.

Discharge products from the FBI include particulates (ash), minor quantities of sand, hot air (1,500° F), and some vaporized acids and metals.

Heat Recovery

Heat recovery will be accomplished with two air/air heat exchangers and one waste heat boiler per FBI train. The first or primary heat exchanger captures heat from the FBI exhaust stream to preheat the fluidization supply air to temperatures in the range of 750 to 900° F. A waste heat boiler extracts additional heat from the exhaust stream from the primary heat exchanger. The waste heat boilers are designed to produce steam at 700° F and at a pressure of 400 psig. When a train is operating at capacity (i.e., 105 dtpd), the waste heat boiler can generate 18,000 pounds of steam per hour. This steam converted into electricity will produce about 1,500 kilowatts (kW) of power. The steam turbine is sized to convert the 36,000 pounds (capacity of two FBI trains) of steam per hour into electricity and produce 3,000 kW of electricity.

Exhaust air from the waste heat boiler passes through a dry electrostatic precipitator for removal of dry ash, and then enters the secondary air/air heat exchanger. This heat exchanger transfers heat from the exhaust air stream upstream of the wet scrubbers to downstream of the wet scrubbers. Wet scrubbing decreases the exhaust stream temperature to approximately 120° F, which can result in moisture condensing in the exhaust stack. By capturing some of the residual heat in the exhaust stream upstream of the wet scrubbers, that heat, when added back to air stream downstream of the wet scrubbers, elevates the air stream approximately 100° F. This addition of heat and heat produced in the induced draft (ID) fan effectively increases the exhaust stream temperature to 250° F as it enters the discharge stack. The higher stack temperature aids plume dispersion, significantly reduces corrosion issues, and reduces the appearance of a steam plume from the stack.

Air Pollution Control System

Air pollution control will be achieved by treating the exhaust combustion gases in a three-step process consisting of dry electrostatic precipitation, wet scrubbing, and wet electrostatic precipitation. Dry electrostatic precipitation removes up to 99 percent of the particulates in the exhaust stream. Wet scrubbing lowers the temperature of the gas stream to condense volatile compounds and removes acid gases, such as sulfur dioxide and hydrogen chloride. Wet electrostatic precipitation removes the volatile compounds condensed in the wet scrubbers and most of the remaining particulates and metals. Products of the process are clean exhaust air that will comply with regulatory requirements, dry ash, and a minor amount of wet solids collected in the wet processes. Exhaust air is pulled through the air pollution control processes and discharged into the stack by the ID fan on each train. Each exhaust stack will extend vertically to elevation 805 feet above sea level or 105 feet above grade. Each stack will be 4 feet in diameter except for a cone at the top to increase the discharge velocity.

Dry ash will be used as an additive in the concrete industry. Solids collected from the wet scrubbing effluent streams containing small concentrations of mercury and other metals will be dewatered and landfilled.

Ash Handling

Dry particulates collected in the waste heat boiler and the dry electrostatic precipitator (ESP) will be pneumatically conveyed to the existing ash silos. The silos are equipped with an existing bag house for capture of the fine ash dust. Four of the existing eight silos provide 30 days of ash storage at the year 2005 annual average plant loadings.

MCES has a contract for utilization of the ash in the manufacture of concrete and other construction products. It is anticipated that this ash utilization program will be continued in the future.

Alkaline Stabilization

Alkaline stabilization is a chemical process designed to produce biosolids for agriculture application. Alkaline materials mixed with the wastewater solids include lime and/or cement kiln dust, coal ash, and occasional small amounts of quick lime to achieve the temperature requirements. The supplemental alkaline stabilization facility will have capacity to stabilize 188 dtpd of dewatered solids. The design ratios of the alkaline materials to dry solids and coal ash to dry solids, based on weight, are approximately 1:1 and 0.8:1, respectively. Thus, for 1 pound of dry solids at a solids concentration of 30 percent, the resultant alkaline stabilized product has a weight of approximately 5.13 pounds (1 lb solids + 2.33 lbs water + 1 lb alkaline material + 0.8 lb coal ash). In addition, 1 ton of alkaline stabilized biosolids occupies a storage volume of 190 cubic feet.

Alkaline processing facilities of storage, feeding and mixing, product storage-monitoring, and odor control facilities are described in the following paragraphs.

Alkaline Material Storage

The Metro Plant has eight existing storage silos, each with an effective volume of 15,000 cubic feet. Four silos will be allocated to ash storage and four to alkaline mixture storage. The four existing silos will provide 10 days of storage of the alkaline add-mixture materials at an average production rate of 75 dtpd. Two silos will be used for the alkaline material and two silos for the coal ash. At projected peak alkaline stabilization loading condition of 188 dtpd of solids, these four existing storage silos provide 4 days of alkaline material storage capacity.

Feeding and Mixing System

The alkaline material and coal ash will be pneumatically conveyed from the existing silos to the new Solids Management Building, where 1,500-cubic feet feed bins are located. Screw feeders transfer the alkaline material and coal ash from the feed bins to one of two mixers, where the solids and alkaline materials are mixed and then conveyed to the truck loadout facility. Off gases from the mixing process and conveyors will be collected and ducted to the odor control facility.

Biosolids Storage and Loading

The new Biosolids Storage Building will include an enclosed truck loading bay and three enclosed storage cells with dimensions of 70 feet in width, 200 feet in length, and a clear interior height of 24 feet. Alkaline product can be stored in any of the three cells in either the truck trailers or in bulk storage.

For a Class A product, the material is retained in the insulated truck trailers through the temperature-monitoring phase. After meeting the temperature requirements, the trailer may be unloaded for bulk storage and pH monitoring. For odor control, all trailer and bulk storage will occur inside one of the three storage cells.

Each cell has bulk capacity to store approximately 1,125 tons of dry solids as an alkaline product (5,770 wet tons of product).

Odor Control

Odor control provisions will be included for the truck loading bay, alkaline mixers, and the three storage cells to prevent the release of odors. Collected air from the alkaline stabilization facilities will be passed through cartridge filters to remove particulates for compliance with air permit limits. Collected particulates will be landfilled or recycled through the solids load-in facility and fed to the FBIs.

Downstream of the cartridge filters, the air will pass through four parallel packaged odor scrubbing units each designed to treat 24,500 cfm of air. The scrubbers are single pass, three-stage packaged absorption system. Acid treatment in the first stage removes ammonia, followed by two stages to treat hydrogen sulfide and other compounds. The air first enters the acid stage in a counter-current flow, and contacts a recirculation stream of sulfuric acid where all of the ammonia is removed. The gas then passes through a mist eliminator in order to rid the air stream of any acid vapors. In the second stage, the gas flows co-current where it contacts fresh sodium hydroxide solution to oxidize most of the hydrogen sulfide. Final polishing occurs in the third stage where the gas flows counter-current with sodium hydroxide and hypochlorite solution. This scrubbing system is designed to achieve 99 percent removal of ammonia and hydrogen sulfide in the untreated air stream, which may contain concentrations of ammonia and hydrogen sulfide as high as 50 and 25 mg/l, respectively.

Air exchange rates of 12, 6, and 2 changes per hour are planned for the truck loading bay, active storage cells, and inactive storage cell, respectively. The design is based on two cells being active simultaneously. Should only one cell be active, the air exchange rate could be increased to 10 air changes per hour in the active storage cell. The total air flow requiring treatment is estimated at 98,000 cubic feet per minute.

It is not feasible to eliminate odors from inside the truck loading and storage cells. For example, the ammonia concentrations within the storage cells are anticipated to require all personnel to wear respirators. This could be a labor issue in the future.

Air Pollution Control

Air emissions from the alkaline storage system will be included in the project air permit application.

A cartridge air filtration system will be included that provides the optimum particulate removal and avoids limiting system operations. The cartridge filter system consists of four parallel units each having a surface area of approximately 3,500 square feet.

Sizing Criteria

Sizing criteria for the Solids Processing Improvement Project facilities are summarized in Table 3-1.

Facility Layout

Proposed facilities are located on the Metro Plant Site east of the East Primary tanks as shown on Figure 3-2. The new Solids Management Building is approximately 360 feet long and 168 feet wide. The exhaust stacks from the energy recovery process are located at the north end of the building to avoid the St. Paul Airport approach air space to the extent possible. The Federal Aviation Administration has approved a stack height of 105 feet above ground level in the location shown.

Figure 3-3 provides a section view of the new Solids Management Building from the west side of the building looking east. As shown, the south end of the building houses the centrifuge dewatering equipment located on the upper floor of the building. The dewatered solids cake is discharged from the bottom of the centrifuges to conveyors on the lower floor that transfer the cake to the alkaline mixing equipment or to the FBI feed bins. The building will also include provisions for external cake load-in. Cake pumps used to pump the dewatered cake to the fluid bed incinerators will be located on the ground floor.

Table 3-1
Facility Sizing Criteria

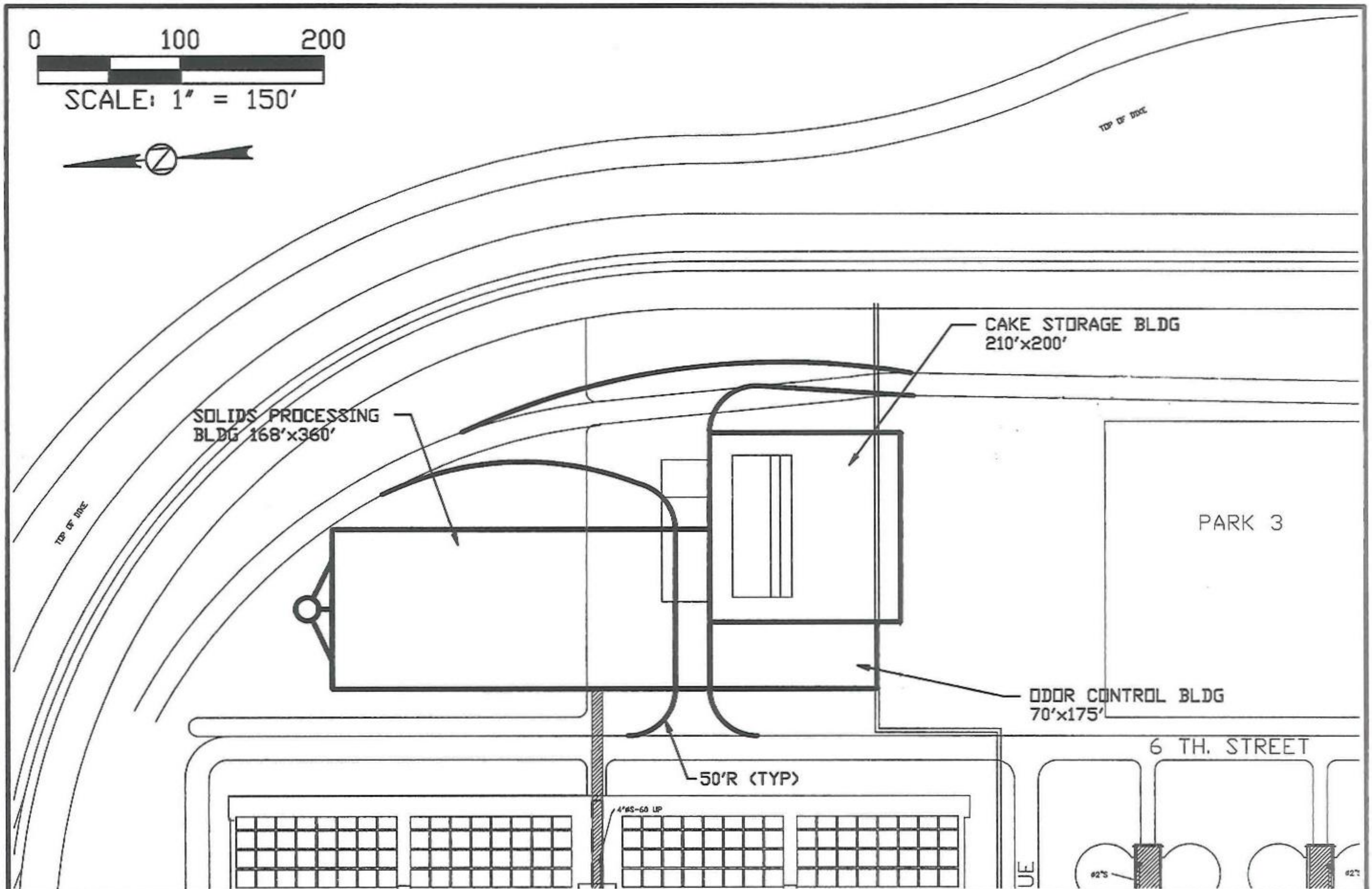
Sizing Criteria	Units	Year 2005 Annual Ave.	Year 2005 Peak Wk	Year 2025 Annual Ave.	Year 2025 Peak Wk
Solids Loading					
Dry Solids	dt/d	279	380	315	419
Wet @ 4.8 % Solids	gpm	968	1318	1093	1454
Volatile Fraction	%	77%	77%	77%	77%
Centrifuge Dewatering System					
Capacity Per Unit	gpm	220	220	220	220
Number of Operating Units	no.	5	6	5	7
Operating Capacity	gpm	1100	1320	1100	1540
Number of Units Installed	no.	7	7	8	8
Capture	%	95%	95%	95%	95%
Dewatered Solids	dt/d	265	361	299	398
Dewatered solids Conc.	%	30%	30%	30%	30%
Polymer Requirements	lbs/dt	8	8	8	8
Energy Recovery Stabilization System					
Number of Trains	no.	3	3	3	3
Dry Solids Load per Train	dt/d	105	105	105	105
Total System Capacity	dt/d	315	315	315	315
Biosolids Stabilization System					
Number of Trains	dt/d	2	2	2	2
Dry Solids Load per Train	dt/d	100	100	100	100
Total System Capacity	dt/d	200	200	200	200
Total Stabilization System Capacity					
Total Installed Capacity	dt/d	515	515	515	515
Capacity w/o Largest Train	dt/d	410	410	410	410
Excess Capacity	dt/d	145	49	111	12
Energy Recovery System Components	(same for all loading conditions)				
Fluid Bed Reactors					
Number	no	3			
Bed Diameter	ft	20			
Free Board Diameter	ft	30			
Fluidization Air Flow	scfm	17,000			
Evaporative Capacity/reactor	Tons/hr	10.2			
Primary Heat Exchangers	no.	3			
Waste Heat Boilers	no.	3			

Table 3-1
Facility Sizing Criteria

Sizing Criteria	Units	Year 2005 Annual Ave.	Year 2005 Peak Wk	Year 2025 Annual Ave.	Year 2025 Peak Wk
Steam Recovery	lbs/hr/unit	18,000			
Steam Pressure	psi	400			
Steam Temperature	Degree F	700			
Dry Electrostatic Precipitator	no.	3			
Dry Ash Capture	%	95%			
Quencher and Wet Scrubber	no.	3			
Wet Electrostatic Precipitator	no.	3			
Secondary Heat Exchanger	no.	3			
Induction Fans	no.	3			
Flowrate	acfm	23,500			
Ash Quantities	dt/d	61.0		69	
Particulate Emissions					
PM Particles	grains/dscf	0.5			
PM 10 Particles	grains/dscf	0.45			
Biosolids Stabilization System					
Basic Sizing Criteria					
Alkaline/Dry Solids Ratio	ratio	1			
Coal Ash/Dry Solids Ratio	ratio	0.8			
Dry weight per ton dry solids	t/t	2.8			
Wet Weight per ton dry solids	t/t	5.13			
Bulk Density of Wet Product	lbs/cf	55			
Bulk Density of Alkaline Mat'l	lbs/cf	60			
Bulk Density of Coal Ash	lbs/cf	55			
Wet Volume of ton dry solids	cf/tds	187			
Storage of Alkaline Materials	days	10			
Storage of Alkaline Product	days	45			
System Maximum Capacity	dt/d	200			
Number of Alkaline Mixers	no.	2			
Mixer Capacity	wt/hr	50			
Size of Facilities Based on Average Production Rate and Basic Sizing Criteria					
Average Production Rate	dt/d	75			
Alkaline Material Storage	tons	750			
Alkaline Material Storage	cf	25,000			
Net Capacity of Existing Silos	cf	15,000			
Req'd Silos for Alkaline	no.	2			
Coal Ash Storage	tons	600			
Coal Ash Storage	cf	21,800			

Table 3-1
Facility Sizing Criteria

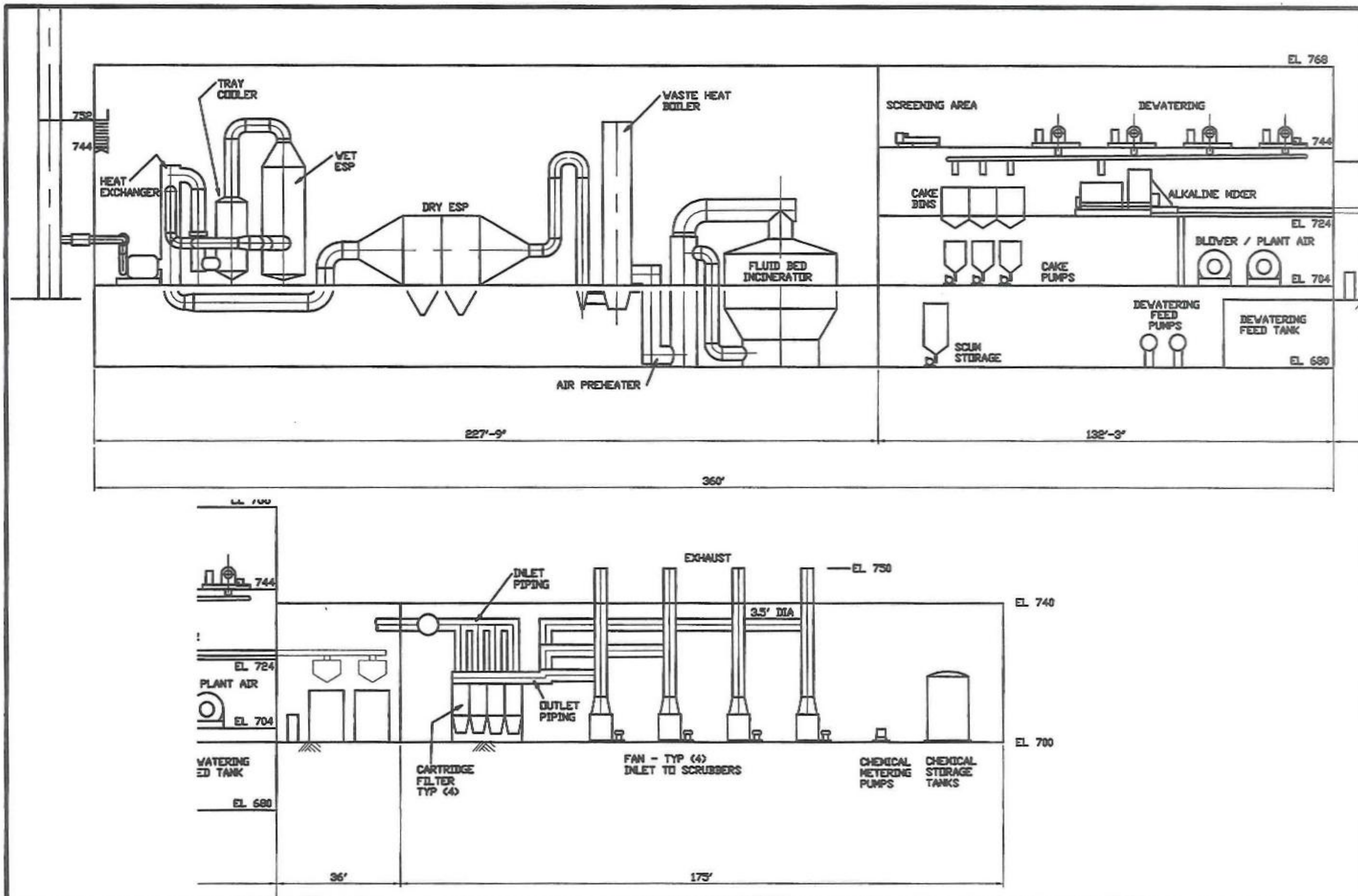
		Year 2005		Year 2025	
Sizing Criteria	**Units**	**Annual Ave.**	**Peak Wk**	**Annual Ave.**	**Peak Wk**
Req'd Silos for Coal Ash	no.	2			
Biosolids Storage	wet tons	17,310			
Biosolids Storage	cf	629,500			
Storage Cell (200'lx70'wx15'd)	cf	210,000			
Req'd Number of Storage Cells	no.	3			
Wet Tons of Production/day	wt/d	385			
Truck Capacity	wt/load	20			
Truck Loads/day	Loads/d	19.3			
Number of Truck Trailers Req'd	no.	20			
Air Emission Control System					
Average Cell Height	ft				
Air Changes Per Active Cell	ac/hr	6			
Air Changes Per Inactive Cell	ac/hr	2			
Air Changes for Truck Loading	ac/hr	12			
Maximum Number of Active Cells	no.	2			
Air Flow From Active Cells	cfm	67,200			
Air Flow From Inactive Cells	cfm	11,200			
Air Flow From Truck Loading	cfm	16,600			
Air Flow From Alkaline Mixing	cfm	3000			
Total Air Flow	cfm	98,000			
Air Emission Control Train Cap.	cfm	24,500			
Number of Air Emission Control Trains	no.	4			
Air Emission Control Train Components					
Cartridge Filters	sf	16,000			
Acid Scrubber	no.	1			
Caustic Scrubber	no.	1			
Hypochlorite Scrubber	no.	1			
Treated Air Quality					
PM Particles	grains/dscf	0.005			
PM 10 Particles	grains/dscf	0.0008			
Ammonia	mg/l	0.5			
Hydrogen Sulfide	mg/l	0.25			



Metropolitan Council
Environmental Services

SITE PLAN
MWWTP Solids Processing Improvements
Facility Plan

Figure 3-2



Metropolitan Council
Environmental Services

SOLIDS PROCESSING BUILDING
MWWTP Solids Processing Improvements
Facility Plan

Figure 3-3

The FBIs and down stream heat recovery and air pollution control equipment will be located on the north end of the building, with the air flow going from south to north.

Ash collection equipment will be located in the basement below the waste heat boilers and dry electrostatic precipitators.

The new Biosolids Storage Building will be located immediately south of the new Solids Management Building. The odor control building will be adjacent to the truck loading and storage facilities. Truck access into the storage cells is located on the east side of each cell. Air flows within the storage cells will travel from east to west with those working within a cell to primarily be on the fresh air side to the stored material.

The Metro Plant property falls within the 100-year floodplain according to the Federal Emergency Management Agency (FEMA) 1989 Flood Insurance Rate Map. The base flood elevation is shown as 705 feet National Geodetic Vertical Datum (NGVD). The plant is protected by a levee and floodwall that is designed to handle the 100-year flood elevation. The levee averages about 716 feet NGVD. The new solids processing facilities will be located inside this levee.

Recommended Alternative – Project Costs

The Metropolitan Council based its technology decision, in part, on cost estimates prepared at an equal level of detail for all alternatives, as presented in Section 6 – Alternative Evaluation. After Council made the technology decision, a more refined cost estimate was prepared for the preferred alternative only. This refined cost estimate is to be used for capital improvement planning purposes.

Capital Cost

The refined capital cost estimate for the Solids Processing Improvement Project was prepared using the following procedures:

1. Requesting manufacturer quotations for major equipment items
2. Performing a preliminary structural analysis to quantify structural quantities and unit costs
3. Including percentage allowances for:
   - General sitework
   - Architectural
   - Heating, ventilation, and air conditioning (HVAC)
   - Plumbing
   - Electrical and instrumentation.
   - Undefined facilities and construction requirements
   - Contractor overhead and profit

Table 3-2 summarizes the estimated project costs in current 1998 dollars.

TABLE 3-2
Estimated Capital Costs

Category	Amount
Earthwork and Foundation Piling	$ 6,400,000
Concrete	10,000,000
Masonry	600,000
Metals	5,400,000
Thermal and Moisture Protection	600,000
Equipment	64,000,000
Mechanical	13,700,000
Allowances:	
Civil-site	700,000
Architectural	1,900,000
Instrumentation	8,300,000
Electrical	9,700,000
HVAC	3,900,000
Plumbing	1,500,000
Painting & Finishes	1,000,000
TOTAL CONSTRUCTION COST	**$127,700,000**
Contractors Overhead and Profit (15%)	14,100,000
Undefined Details/Equipment (15%)	20,800,000
Engineering, Administrative & Legal (16%)	25,500,000
TOTAL CAPITAL COST (1998 $)	**$188,100,000**

In general, this project estimate covers similar project elements as the estimates for the alternatives presented in Section 6. The recommended alternative is most similar to Alternative 2 – Three Fluid Bed Incinerators with Alkaline Stabilization as presented in Section 6. The different elements between the recommended alternative and alternatives in Section 6 include the following:

1. Auxiliary boilers are included in the preferred alternative but were not included in any alternative in Section 6.

2. Purchase of centrifuges was included in all alternatives in Section 6 but is not included in the recommended alternative since they are scheduled to be purchased under a different MCES project.

3. Enclosed storage facilities for alkaline stabilized biosolids, including odor control, are included in the recommended alternative, but were not included in Alternative 2 in Section 6.

4. Based on the increased level of detail in the recommended alternative cost estimate, the allowance for undefined details/equipment is reduced to 15 percent, as compared to 25 percent used for the alternatives in Section 6.

5. Based on the increased level of detail in the recommended alternative cost estimate, the allowance for engineering, administration, and legal costs is reduced to 16 percent, as compared to 25 percent used for the alternatives in Section 6.

Items not specifically included in the cost estimate but required for the project are:

- Revisions to the steam distribution system within the existing plant to accommodate the new supply source
- Repair or modifications to the existing silos other than installation of the new transporters
- Maintenance facilities
- Offices and supply rooms for the different trades
- Any patent fees for the alkaline stabilization process

Capital cost estimates shown above have been prepared for guidance in project evaluation and implementation from information currently available. The final costs of the project will depend upon actual labor and material costs, competitive market conditions, final project scope, implementation schedule, inflation rate, interest rates, and other variable factors. As a result, the final project costs will vary from the above estimate.

Operation and Maintenance (O&M) Costs

The refined O&M costs are included in Appendix A. The refined O&M costs were prepared with the aid of manufacturers equipment catalog submittals for nearly all of the process equipment. Manufacturer's information included equipment costs, motor sizes and annual chemical requirements. In addition, the annual O&M costs are based on annual alkaline stabilized biosolids production equivalent to ten percent of the Metro Plant's total annual solids quantity.

This detailed information resulted in a substantially more accurate estimate of O&M costs than was previously possible.

Section 4
Implementation Plan

Overview

This section defines MCES's objectives and approach for implementation of the Solids Processing Improvement Project at the Metro Plant. In summary, MCES's objectives include:

1. Responsible and cost-effective schedule management with delivery of operating facilities before year 2005.
2. Integrated use of multiple delivery options including design/build, equipment pre-purchase, and design/bid/build to achieve the most cost-effective project delivery with the least risks.
3. Sizing construction packages to enable cost-competitive construction by local general contractors.

Major Project Elements

The Project has the following five major elements:

- In-Plant Mechanical Work
- Centrifuge Dewatering Equipment
- Fluid Bed Incineration and Air Pollution Control Systems
- Solids Management Building
- Biosolids Facilities

In-Plant Mechanical Work

In-plant mechanical work primarily consists of extending utilities to the Solids Management Building; modifying piping and ventilation ducting within the existing plant tunnels to accommodate the added utility services; upgrading solids storage facilities; adding dense phase conveyance equipment to transport ash to the existing silos; and constructing facilities to convey solids and scum to the new facilities and return recycles to the existing plant processes. Scrubber water supplied from the East and West Secondary effluent water supplies will be rerouted from the existing 408 Complex to the new facilities. Likewise, steam supply for plant heating will come from the new facilities versus the existing 408 Complex.

Existing solids storage facilities will be upgraded to provide equalization of solids feed to the dewatering equipment. It is anticipated that four of the existing eight solids storage tanks will be converted to equalization basins. This will require reconstruction of the aeration system within each 700,000-gallon tank, new aeration blowers, and pumps to convey the equalized solids to the solids screens and dewatering feed tanks located in the Solids Management Building. Dewatering centrate and underflow from the scum concentration tanks will be conveyed from the new facilities back to the existing plant primary effluent channels.

This in-plant mechanical work is physically separated from the major construction work associated with the new Solids Management Building, and is appropriate for construction by a qualified local contractor. Design requirements will require integration with other project elements by a design engineer.

Centrifuge Dewatering Equipment

MCES has concluded a performance-based operational test between two major centrifuge manufacturers and will be purchasing six or more centrifuges from the manufacturer with the lowest life-cycle costs, based on 1 year of side-by-side testing. MCES will furnish this equipment for installation by the contractor responsible for delivering the new Solids Management Building.

Fluid Bed Incineration and Air Pollution Control Systems

Three parallel trains consisting of a fluid bed incinerator (FBI), heat exchanger, fluidizing air blower, waste heat boiler, dry electrostatic precipitator, heat exchanger, wet quench and scrubber in combination with a wet electrostatic precipitator, and induced draft fan have been approved as the preferred solids stabilization technology. These equipment trains will be required to meet specific performance requirements. Therefore, it is appropriate for equipment manufacturers to design, construct, and initially supervise operation to prove compliance with the specified performance requirements (i.e. design/build delivery). In defining requirements, the MCES will establish minimum equipment features, financial responsibilities, performance requirements, testing protocol, and delivery schedules for coordination with other project elements.

This design/build procurement approach is required for early definition of system requirements to design structures and utilities to house and support the FBI and energy recovery process equipment.

Solids Management Building

This structure is on the critical path for construction completion of the Solids Processing Improvement Project. Building dimensions are approximately 170 feet wide and 360 feet long, with basement floor and roof elevations of 680 and 770 feet above sea level, respectively. All solids treatment processes will be performed within the building except biosolids loading and storage.

Final building design cannot be completed until the selection and initial design of the FBIs and air pollution control equipment is completed. Therefore, this delays the bidding and initial construction of the building. Secondly, installation of the large incineration and air pollution control equipment cannot occur until construction of the building pile foundation system and basement walls are completed.

To expedite the design and construction process, minimize construction change orders, and reduce construction costs, conventional design/bid/build project delivery is recommended. This allows the design of the scum and solids dewatering processes to proceed in parallel with the design/build procurement of the incineration and air pollution control system. Secondly, it provides a mechanism to integrate the building construction and installation of the FBI system without significant contract change orders, since the building contractor will have incineration system shop drawings when bidding the project. Finally, the design and construction of the building may be tailored to the specific dimensions and loads of the installed incineration and air pollution control equipment, versus a conservative design that would cover multiple configurations of equipment from several potential manufacturers.

A design/build delivery process for the Solids Management Building could not proceed until the FBI and air pollution control supplier had been selected and completed the initial design. This would significantly delay the building design and construction and ultimate delivery of an operable system.

Biosolids Facilities

These facilities include a truck loading complex, a biosolids storage building and an odor control facility to control air emissions from the biosolids facilities. Truck loading facilities include two bays for parallel loading of biosolids trucks. A biosolids storage bin is located above each bay to facilitate truck loading. The truck loading area is enclosed for odor and air emission control.

Biosolids storage facilities consist of three enclosed cells, each 200 feet long and 70 feet wide, with a clear height of approximately 24 feet. Each cell is isolated to provide optimum air ventilation and capture control.

An attached odor-air emission control facility is provided to collect air from the biosolids mixers and conveyors, truck loading area, and the biosolids storage complex. Air flows of up to 98,000 cubic feet per minute will be treated in four parallel trains with each train including the following:

- Cartridge filters for removal of particulates
- Acid scrubber for removal of ammonia
- Caustic scrubber for removal of hydrogen sulfide
- Caustic-hypochlorite scrubber for final polishing and removal of hydrogen sulfide
- Fan

This complex can be executed using either a conventional design/bid/build or design/build delivery process.

A completed facility is not required until approximately 40 months into the project schedule. Consequently, accelerated implementation is a disadvantage, as it would unnecessarily accelerate the expenditure of capital resources. Conventional design/bid/build has the following advantages:

- The construction would be available to a larger number of local contractors, which would increase construction competition and provide better construction pricing. Design/build would be restricted to a fewer number of project teams due to the cost of preparing design/build proposals.

- The connection of the Biosolids Facilities to the Solids Management Building can be better coordinated by the Solids Management Building Designer than the design-builder, thus reducing construction change orders at the interface of the two construction contracts.

- Coordination of electrical and instrumentation design favors design of the facilities by the Solids Management Building Designer.

Schedule

A project implementation schedule is presented on Figure 4-1, and is based on the following project delivery approach.

Facility	Delivery Mechanism
In-Plant Mechanical Work	Design/Bid/Build
Dewatering Centrifuges	MCES Pre-purchase and Contractor Install
Fluid Bed Incineration and Air Pollution Control Systems	Design/Build
Solids Management Building	Design/Bid/Build
Biosolids Facilities	Design/Bid/Build

The schedule is dependent upon MPCA reviews and final approval, and assumes MPCA will issue an air permit by December 1999. This delivery approach will achieve full operation of all facilities by the end of calendar year 2003, which is 2 years in advance of the Master Plan project delivery goal.

Summary

The project implementation plan presented herein achieves MCES objectives. Project completion is 2 years ahead of the original schedule. Three delivery mechanisms are employed to provide the most cost-effective delivery system. In addition, separating the In-Plant Mechanical Work and the Biosolids Facilities will enable cost competitive construction by local general contractors.

ID	Task Name	Duration	Start	Finish
1	**Design**	**516 days**	**Mon 1/4/99**	**Mon 12/25/00**
2	FBI & Air Poll Cntrl Systems	86 days	Mon 1/4/99	Mon 5/3/99
3	Centrifuge Dewat Equip	344 days	Mon 1/4/99	Thu 4/27/00
4	Solids Mg't Bldg	86 days	Thu 12/30/99	Thu 4/27/00
5	Biosolids Facilities	172 days	Fri 4/28/00	Mon 12/25/00
6	In-Plant Mechanical	172 days	Fri 4/28/00	Mon 12/25/00
7	**Bid & Award**	**516 days**	**Tue 5/4/99**	**Tue 4/24/01**
8	FBI & Air Emission	86 days	Tue 5/4/99	Tue 8/31/99
9	Solids Mg't Bldg	86 days	Fri 4/28/00	Fri 8/25/00
10	Biosolids-Odor Cont.	86 days	Tue 12/26/00	Tue 4/24/01
11	In Plant Mechanical	86 days	Tue 12/26/00	Tue 4/24/01
12	**Construction**	**922 days**	**Wed 9/1/99**	**Thu 3/13/03**
13	FBI Shop Dwgs	86 days	Wed 9/1/99	Wed 12/29/99
14	FBI Equip. Fabrication	360 days	Thu 12/30/99	Wed 5/16/01
15	FBI Equipment Delivery	44 days	Mon 8/27/01	Thu 10/25/01
16	FBI Equipment Installation	360 days	Fri 10/26/01	Thu 3/13/03
17	Solids Mgt Foundation	260 days	Mon 8/28/00	Fri 8/24/01
18	Solids Mg't Dewatering	260 days	Mon 8/27/01	Fri 8/23/02
19	Install Dewater Eq't	44 days	Mon 8/26/02	Thu 10/24/02
20	Solid Mg't Complete	352 days	Fri 10/26/01	Mon 3/3/03
21	Biosolids-Odor Cont	352 days	Wed 4/25/01	Thu 8/29/02
22	In Plant Mechanical	352 days	Wed 4/25/01	Thu 8/29/02
23	**Test and Startup**	**232 days**	**Fri 10/25/02**	**Mon 9/15/03**
24	Dewatering	44 days	Fri 10/25/02	Wed 12/25/02
25	Alkaline Stabilization	30 days	Fri 10/25/02	Thu 12/5/02
26	Fluid Bed Incineration	132 days	Fri 3/14/03	Mon 9/15/03

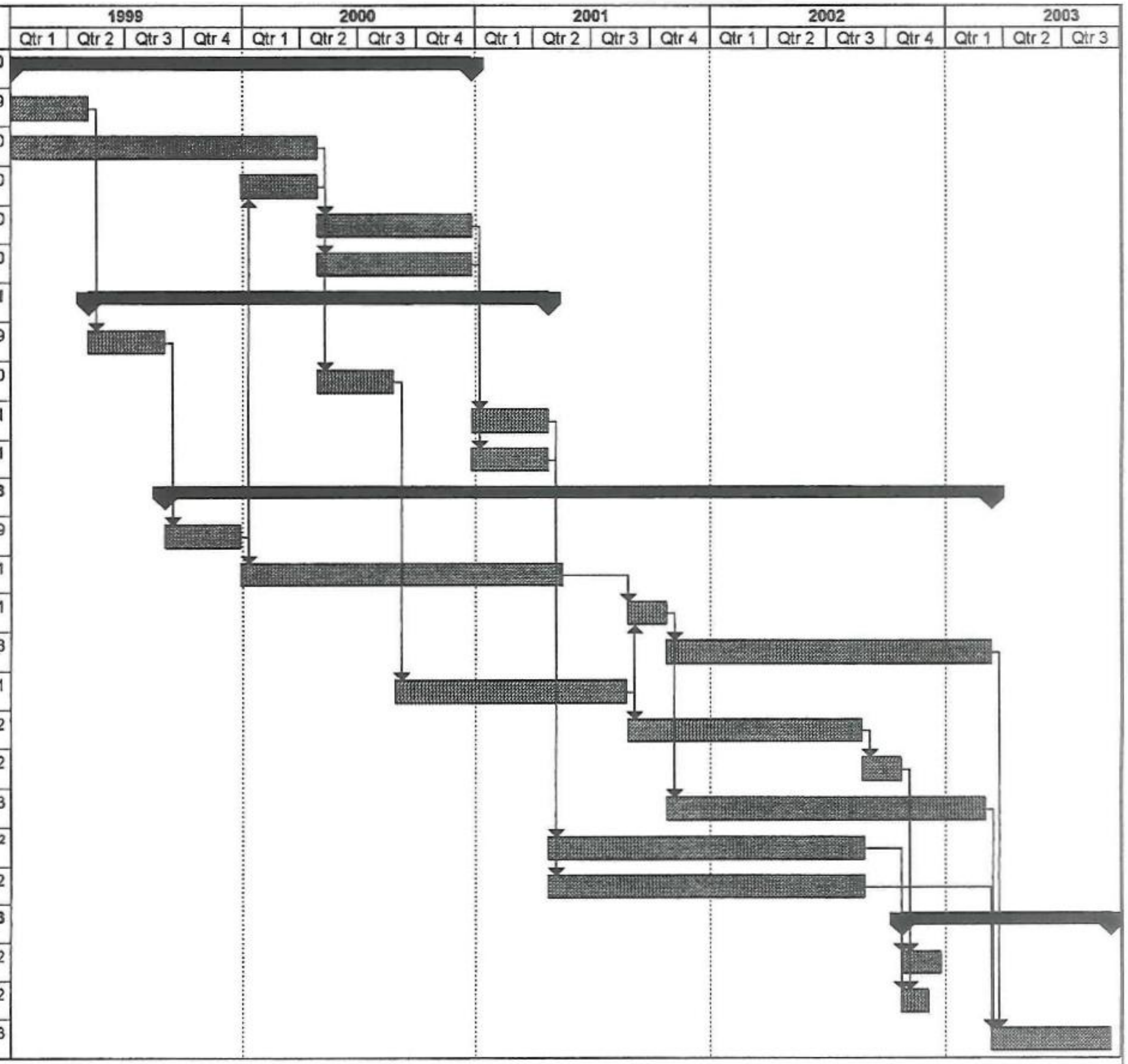


Figure 4-1
Implementation Plan

Task	Summary	Rolled Up Progress	Split
Progress	Rolled Up Task	External Tasks	Rolled Up Split
Milestone	Rolled Up Milestone	Project Summary	

Section 5
Solids Facility Location Analysis

Summary

A siting analysis was completed to select one of two potential sites for the new solids processing facility. The preferred site for the solids processing facility identified in the Metro Plant Master Plan (December 1996) is located in the northeast area of the plant, east of the East Primary tanks. This area is referred to as Site 1 in this analysis. The second site identified for evaluation is located east of the Administration Building and would be located in the space currently occupied by the F&I 1 Building and the east bank of the West Primary tanks. This site is referred to as Site 2. These alternative site locations are shown on Figure 5-1.

The siting analysis was completed early in the facility planning process before the technology alternatives were fully developed. Due to air permitting and air monitoring requirements, it was necessary to select a site before the technology alternatives were fully defined. This section documents the siting analysis process based on the largest footprint required for one fluid bed incinerator (FBI) alternative and one heat dryer alternative, as defined in the Metro Plant Master Plan. The results of the siting study documented in this section indicate that Site 1 is preferred, based on analysis of monetary and non-monetary criteria.

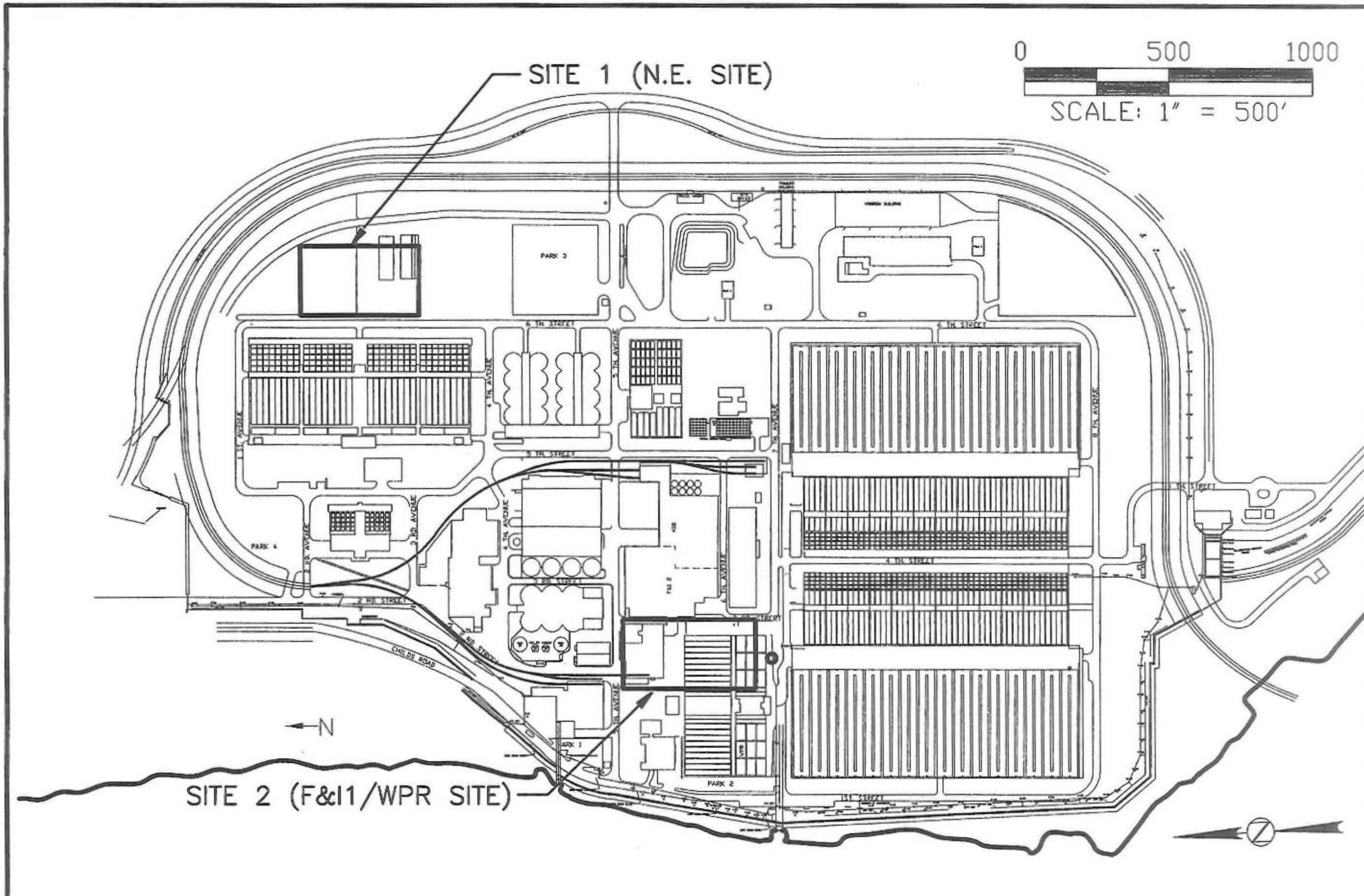
The costs and alternative definition, as presented in Section 6 – Alternative Evaluation, were reviewed as the information pertains to the siting. The updated information does not result in any significant differences in comparative costs or non-monetary factors; therefore, the siting analysis outcome as presented herein does not change. The existing F&I 2 and 408 Buildings were also reviewed as a potential location for the new solids processing equipment. However, due to substantial structural modifications that would be required to retrofit these buildings, this location was not further considered.

The sites were evaluated based on comparative capital costs and non-monetary criteria for both heat drying and FBI technologies. Facility footprints were developed for the technologies to assess space constraints for the two locations.

Site-related capital costs for the two sites were comparable. However, evaluation of non-monetary criteria for the two sites showed an advantage for Site 1. The following advantages were identified for the two sites:

Site 1

- Ease of construction



ALTERNATIVE SITE LOCATIONS
MWWTP Solids Processing Improvements
Facility Plan

Metropolitan Council
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5–1

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- Reduced impacts on operations during construction
- Lower construction risks and expected reduced construction change orders
- Better truck access
- Leaves options for implementing project delivery alternatives
- Leaves space in the core of the plant for future liquid treatment expansion

Site 2

- Reserves space at NE site for future undefined needs
- Solids operations would remain in same area as existing facilities

After comparing the advantages of each site, it was agreed that there were no significant advantages for Site 2, which has significantly more risk in constructability and in maintaining operations during construction. Therefore, this Facility Plan recommends that the new solids processing facility be constructed at Site 1, the NE site location.

Conceptual Footprint Development

In order to assess the applicability of either site for a FBI or dryer technology, conceptual footprints were developed for both technologies. These are shown on Figures 5-2 and 5-3, respectively.

FBI Footprint

The FBI footprint was based on the footprint as defined in the Metro Plant Master Plan and includes the following components:

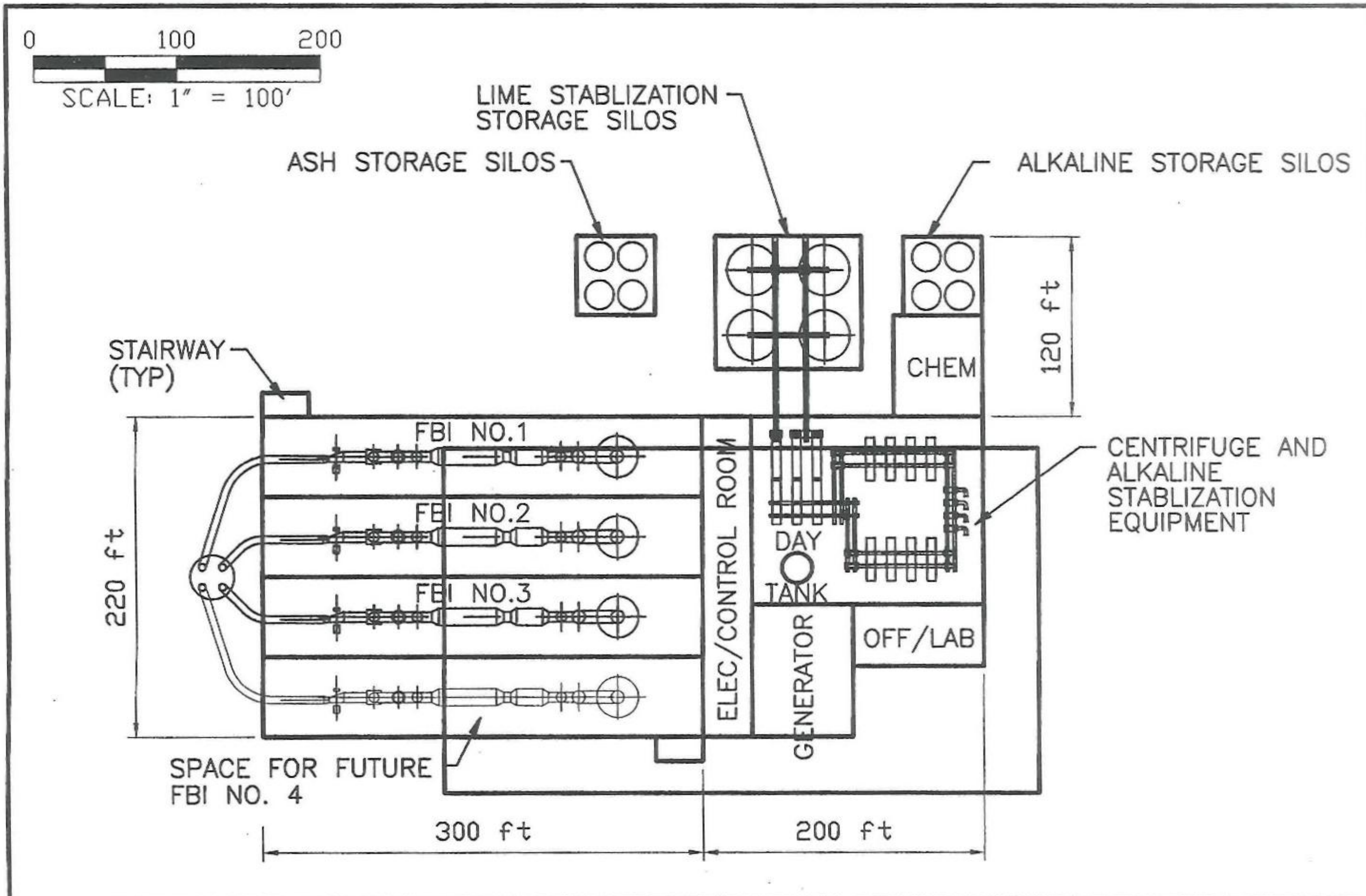
- Three 105-dry ton per day (dtpd) FBIs with space for a fourth FBI
- Combustion and air pollution control train, including heat exchanger, waste heat boiler, dry electrostatic precipitator (ESP), quencher, scrubber, and wet ESP
- Alkaline stabilization equipment for peak loads

The length of the equipment layout train was estimated to be 200 feet. This train length was likely conservative and all the identified equipment may not be required. However, this footprint was identified for planning purposes and to allow space for additional air pollution control equipment that may be required.

The estimated dimension of the FBI portion of the footprint is approximately 220 feet by 300 feet. Other components identified to be included in the FBI facility include:

- Space for eight dewatering centrifuges
- Three pug mills
- Lime storage
- Alkaline stabilized product storage
- Dry product storage
- Office/laboratory, associated electrical and control space.

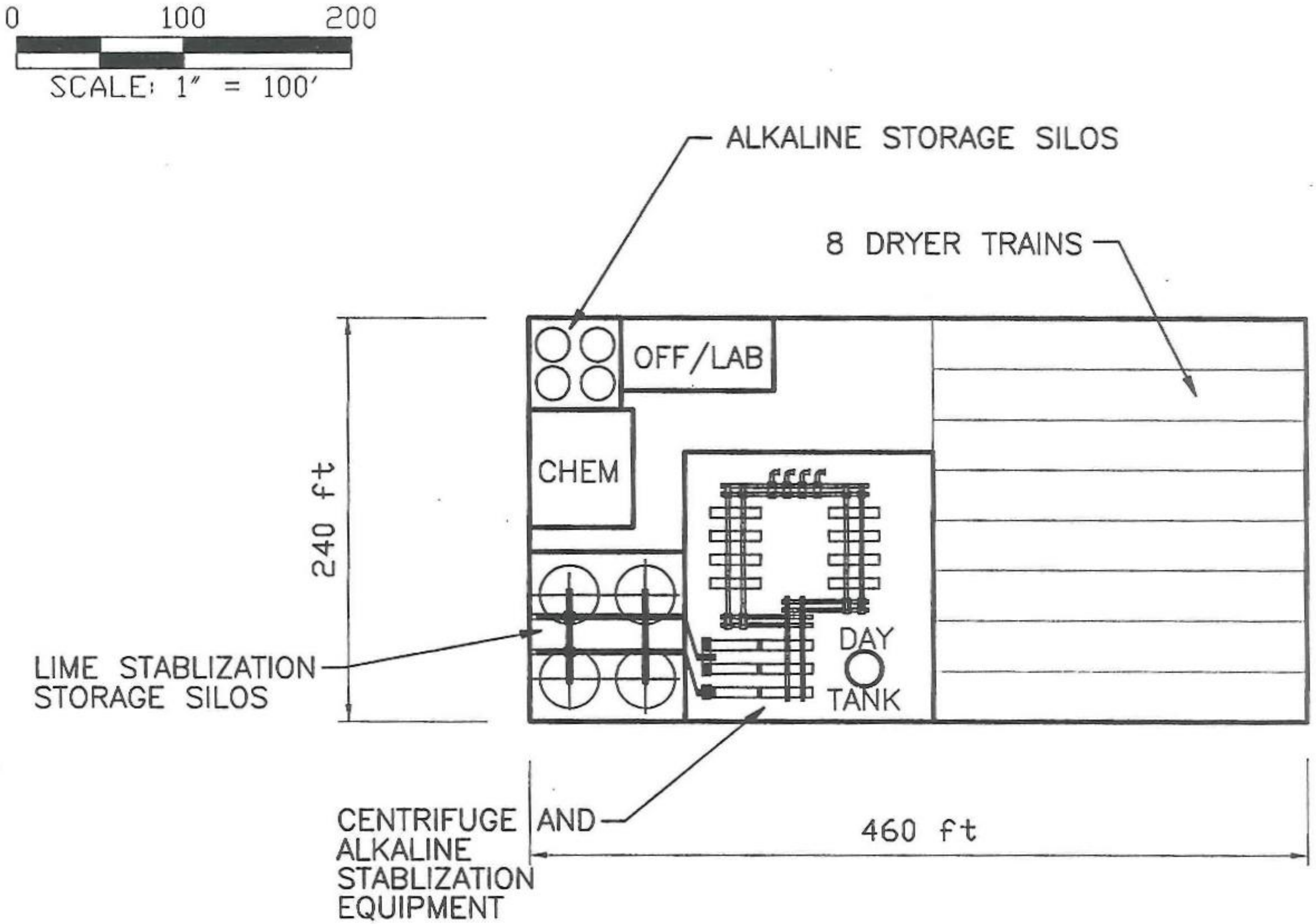
The overall dimensions of the FBI footprint, as shown on Figure 5-2, were estimated at 220 feet by 500 feet, plus 120 feet by 250 feet.



Metropolitan Council Environmental Services

INCINERATOR FACILITY CONCEPTUAL FOOTPRINT
MWWTP Solids Processing Improvements Facility Plan

Figure 5-2



Metropolitan Council
Environmental Services

DRYER FACILITY CONCEPTUAL FOOTPRINT
MWWTP Solids Processing Improvements
Facility Plan

Figure 5-3

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Heat Drying Footprint

A footprint was developed for a heat dryer and dewatering facility with alkaline stabilization sized to process peak loads. This footprint includes:

- Eight heat dryer trains
- Space for eight dewatering centrifuges
- Three pug mills
- Lime storage
- Alkaline stabilized product storage
- Dry product storage
- Office/laboratory, associated electrical and control space.

The overall dimensions of the dryer footprint were estimated to be 240 feet by 460 feet, as shown on Figure 5-3.

Site Considerations

A subsurface geotechnical investigation of the two sites was not completed for the siting study portion of this project. Previous studies and existing boring logs were reviewed to assess expected soil conditions at the two sites.

Soils

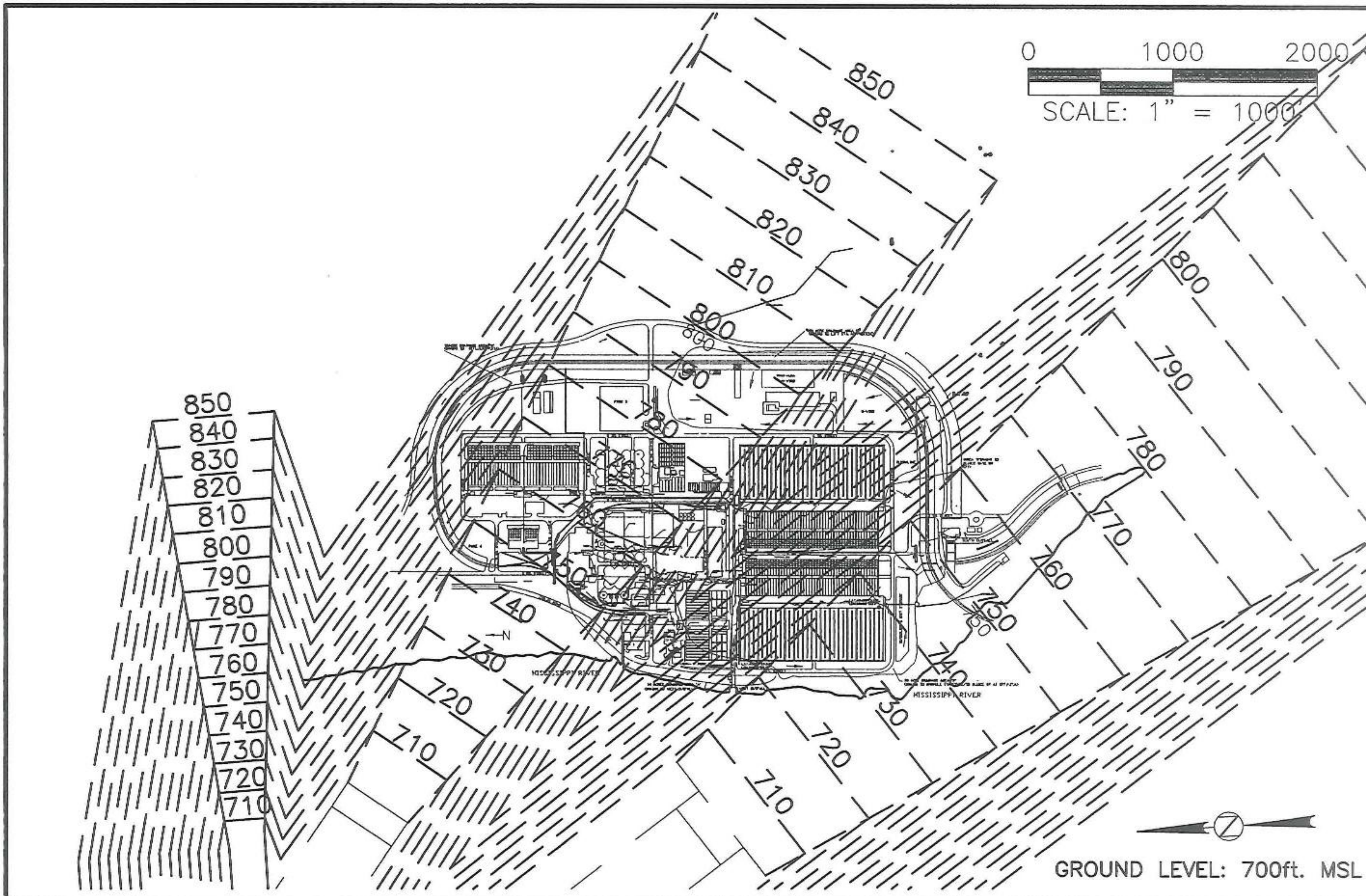
The soils in the vicinity of Site 1 are generally fine-grained soils, including silty sand, silt, clay, and organic materials (as determined from a geotechnical and groundwater study completed as part of the Environmental Inventory and Review Project, Project Number 930405).

For Site 2, a limited number of boring logs from the F&I 1 Building project showed bedrock (sandstone) encountered from 30 to 40 feet below the surface. This was overlain by multiple layers of sand, gravel, and clay. The F&I 1 Building is built on spread footings.

It was assumed that both sites would require piling. The assumed piling lengths for Site 1 and Site 2 were 100 feet and 50 feet, respectively.

Facility Height

For planning purposes, the heights of the dryer and FBI buildings were estimated to be 70 to 90 feet, with stack heights up to 130 feet. The St. Paul Downtown Airport (Holman Field) is located northwest of the Metro Plant on the opposite side of the Mississippi River. This airport has three runways, and the Metro Plant area falls within the approach zones for two of these runways. The heights of any structures within the approach zone contours must be below the contour elevations developed by the Federal Aviation Administration (FAA). Figures 5-4, 5-5, and 5-6 show the approximate approach zones and clear space contours for the sites. Sites 1 and 2 both fall within approach zone contours. The proposed height of the solids processing facility and stack are within the FAA height requirements. The FAA requires an air space review for this condition when proposed facilities are in the approach zones. Results of the air space review indicate that a maximum allowable stack height is 105 feet and maximum allowable building height at 70 feet. A copy of the FAA letter of approval is included in Appendix B.



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APPROXIMATE APPROACH ZONE CONTOURS
MWWTP Solids Processing Improvements
Facility Plan

5-4

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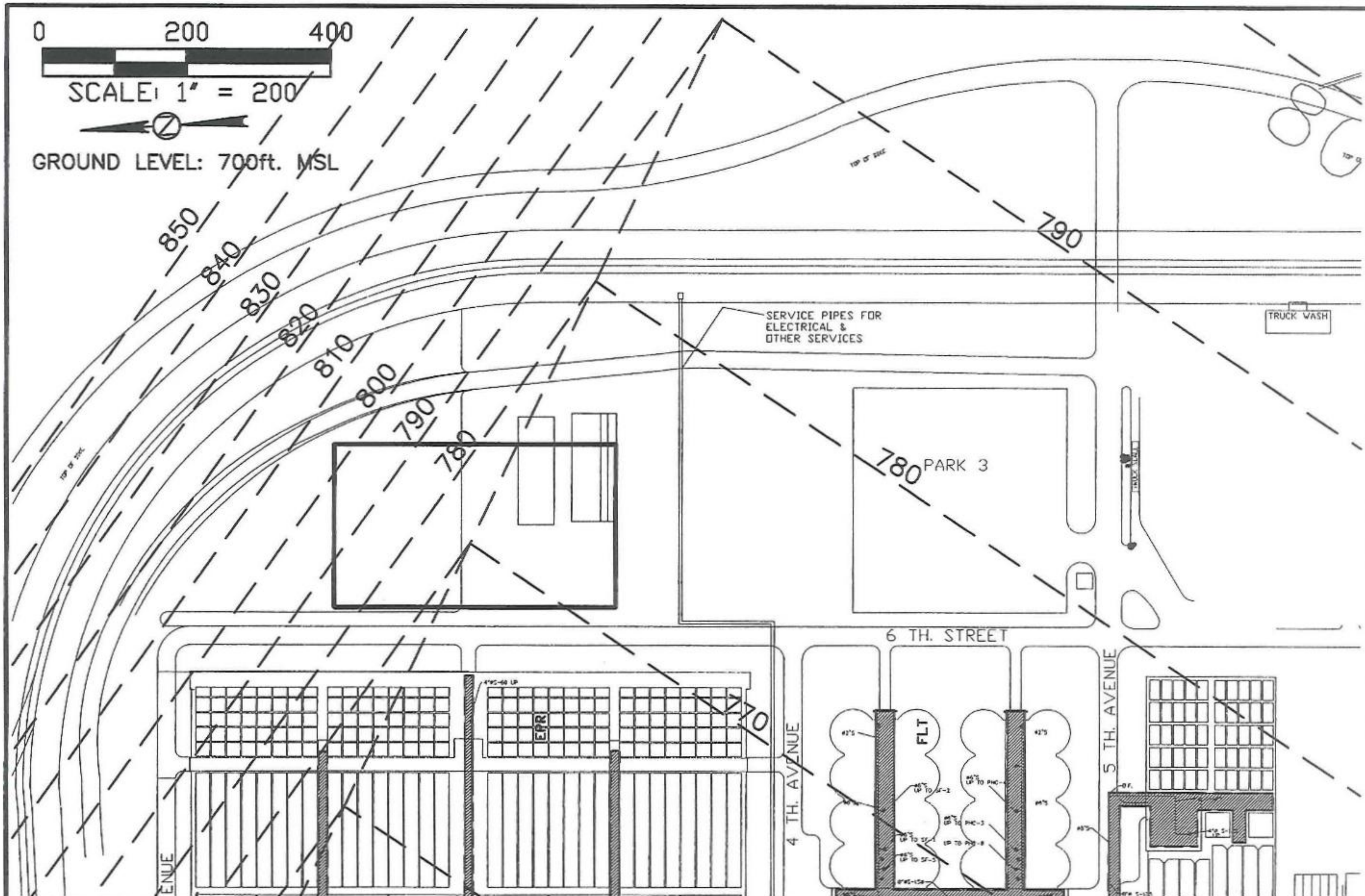

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SITE 1 APPROACH CONTOURS
MWWTP Solids Processing Improvements
Facility Plan

5-5

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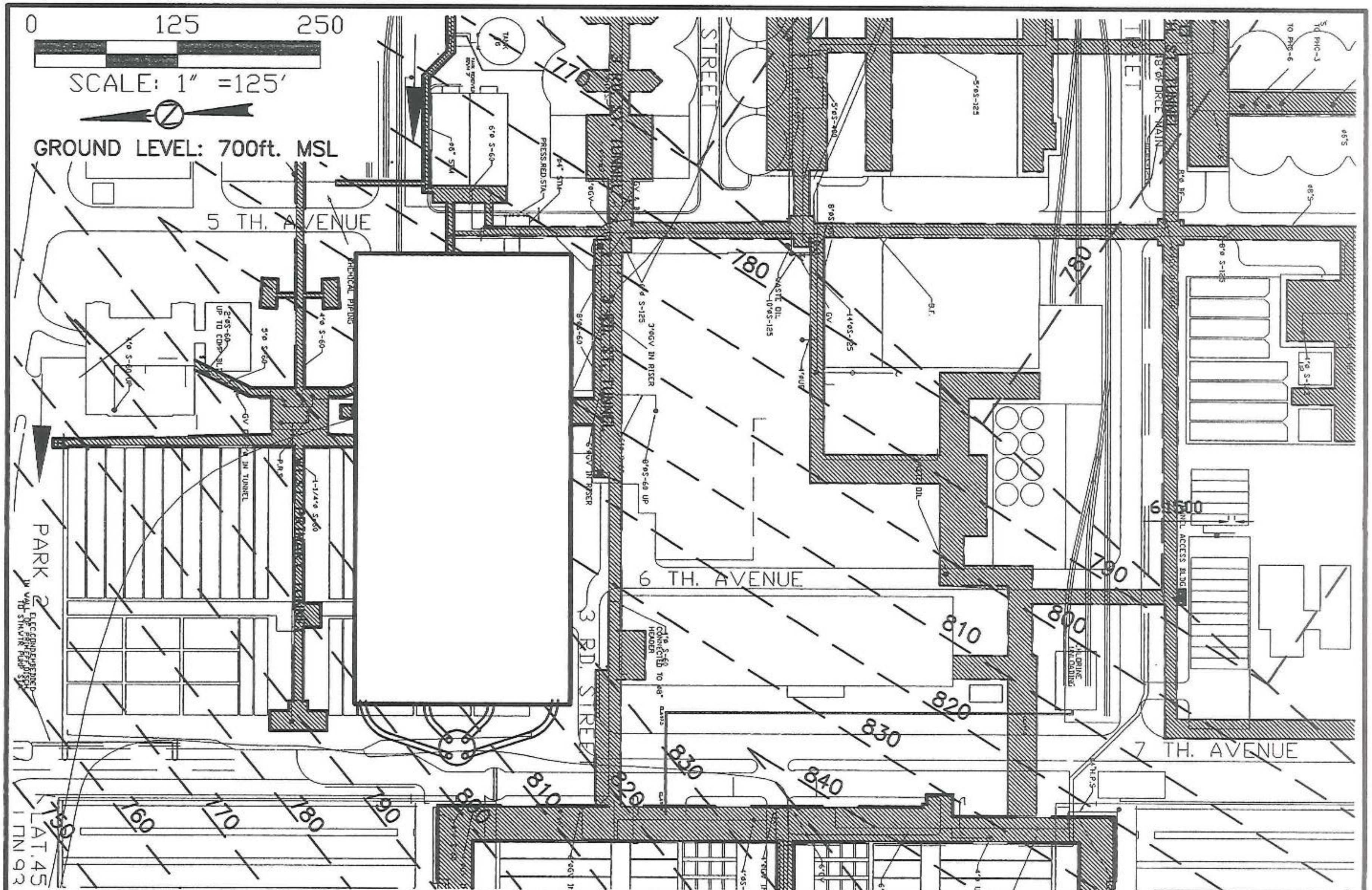

SITE 2 – APPROACH CONTOURS
MWWTP Solids Processing Improvements
Facility Plan

Metropolitan Council
Environmental Services

5–6

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Existing Structures

Site 1 contains two pole building structures that are used for storage. Site 2 contains tunnels, piping, the east bank of the West Primary tanks, and the abandoned F&I 1 Building. Tunnel construction requirements are detailed in a separate section in this chapter. Only minor site work would be required to construct on Site 1; construction on Site 2 would require extensive demolition and tunnel relocation.

Upstream Process Changes

The alternative sites do not require revisions to upstream processes. Conveyance of excess solids from the upstream treatment processes to either site will require pumping and new conveyance pipelines. Longer conveyance pipelines, and corresponding higher pumping head requirements will be required from the solids storage and holding tanks to Site 1.

Electrical Concept for Feeding and Distributing Power

Incineration or heat drying of the design solids quantities will require a substantial amount of electrical power such that a substation will be required at the solids processing facilities. Primary power will be distributed in duct banks at 13.8 kV from the existing primary switch station to either of the proposed sites. Existing duct bank capacity is available for a majority of the distance from the primary south station to Site 2. A new duct bank is required for power distribution to Site 1.

Utility Needs

The FBIs will require natural gas with fuel oil as a backup, fluidizing and burner air, water, and electricity. Heat dryers require more energy for evaporation and are not able to utilize the heat value in the solids as does the incineration process. Therefore, it has significantly higher natural gas requirements.

The following estimated annual amounts of utilities are required to operate the solids processing alternatives.

Estimated Annual Utilities

Technology	Natural Gas	Electricity
Fluid Bed Incineration	36,500 MMBTU/yr	32,698,981 kWhr/yr
Heat Drying	642,638 MMBTU/yr	41,192,550 kWhr/yr

In addition, it is estimated that 100 cu ft/min of instrument air will be required to operate control valves and transducers, not including bag house requirements. The water demand for the facility will include approximately 2,000 gpm for scrubbers, 50 gpm for boilers, 80 gpm for centrifuges, and potable water for personnel use. The instrument air and water use for Sites 1 and 2 is approximately the same.

Utilities Available

Existing Metro Plant utilities include potable water, service water, effluent water, stormwater drainage, natural gas, fuel oil, electricity, instrument and power air, steam and condensate, and telephone.

Although no utilities are currently connected to Site 1, some utilities are in the proximity and may be able to supply Site 1. Potable water is located in the east shoulder of 6th Street. Service water is located just east of the East Primary tanks. The stormwater conveyance line for the NE portion of the plant flows north in the east right-of-way of 6^{th} street.

Instrument air, power air, and steam and condensate systems are located in the East Primary tank complex. The closest effluent water connection is located in the flotation thickener structure. Supply of natural gas or fuel oil to Site 1 would require installation of new piping routed from the F&I 1/ F&I 2 area of the plant. The plant security system would need to be modified to encompass the NE Site.

All utilities are currently located in close proximity to Site 2, and no significant extensions would be required.

Solids Pumping and Conveyance

Solids from existing solids processing areas will be conveyed to the new solids processing facility. Thickened solids will be conveyed from the existing solids storage tanks to the proposed solids processing facility. New piping will be required to convey the solids to Site 1. The Site 2 location would require some extensions of existing piping.

Transferring solids from one location to another requires consideration of the following factors:

- Pipe sizes to limit clogging
- A consistent velocity range to maximize the fluid properties of solids without turbulence and air entrainment
- Maintenance access points
- Redundancy

Thickened Primary Solids: Gravity thickened primary solids at the Metro Plant typically ranges from 5.5 to 7.0 percent solids. Undigested solids require a minimum pipe size of 6-inch diameter and pumping velocity of 4 to 6 feet per second (ft/sec).

Flotation Thickeners (Thickened Waste Activated Solids): Dissolved air flotation thickened waste activated solids at the Metro Plant typically range from 3.5 to 4.5 percent solids. A minimum pipe size of 6 inches in diameter and velocity of 2 to 4 ft/sec should be maintained.

Solids Storage Tanks (Thickened Waste Activated and Thickened Primary Solids): The eight existing solids storage tanks are located east of the Thermal Conditioning Building. Solids storage tanks receive thickened secondary solids from flotation thickeners and thickened primary solids from the gravity thickeners. It is anticipated that solids in the solids storage tanks will be approximately 4 to 6 percent solids. A minimum 6-inch pipe with flow velocity of 4 to 6 ft/sec is recommended to transfer this combination of thickened solids.

Tunnel Construction Requirements

The existing tunnel system is critical in the daily operations of the Metro Plant. The tunnel system contains a complicated network of piping and utilities, and provides for staff and maintenance access. A majority of the process piping and support utilities are routed through the tunnel system.

To maintain operations, the existing tunnel system needs to be protected, or relocated, during any period of construction.

Site 1—NE Site

There are no existing tunnels on the proposed Site 1, and extension of an existing tunnel will be necessary to connect this site to the plant tunnel system. Figure 5-7 shows existing tunnel structures near proposed Site 1 and alternative tunnel extensions.

The tunnels in the vicinity of Site 1 are at the East Primary tanks, flotation thickener tanks, and along 5^{th} Street, which is on the east side of the East Primary tanks and flotation thickener tanks. Site 1 can be connected to the tunnel system by extension of the East Primary and/or flotation thickener tunnels. Tunnel extension to Site 1 from the north-south tunnel along 5^{th} Street would not be possible, due to the East Primary effluent barrel. This barrel is located along the south end of the East Primary tanks and along 5^{th} Street, and is constructed on piling.

The proposed tunnel extension would house electrical service, water service, air service, and process piping. It would also provide personnel and equipment access.

Site 2—F&I 1 Site

Site 2 is located in an older area of the plant and is constrained by tunnels or structures on every side. Figure 5-8 identifies the tunnels and structures in the Site 2 area.

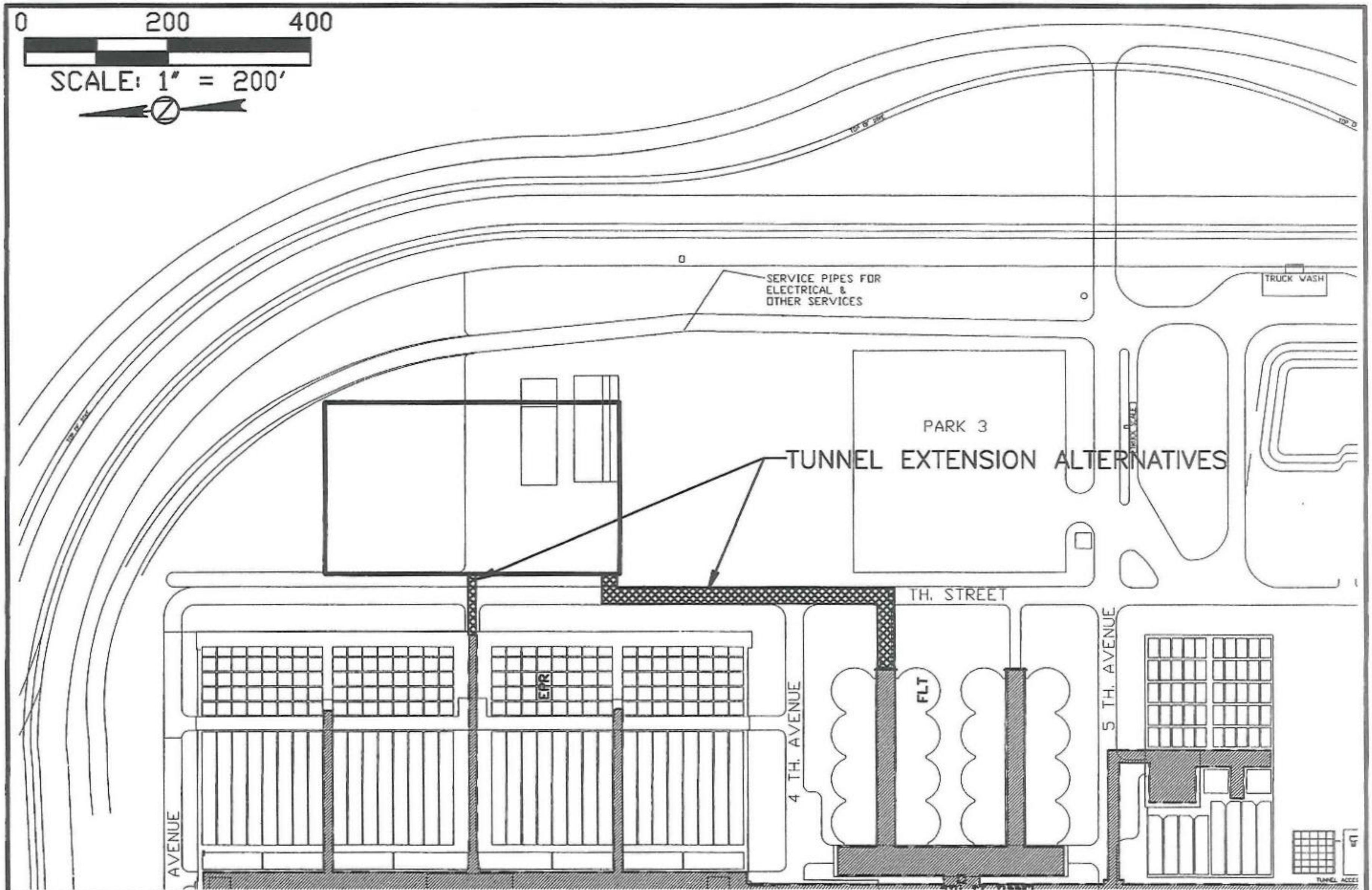
The following tunnels fall outside the solids facility footprint but would require protection during construction:

- North-south tunnel along 3rd Street between F&I 1 and F&I 2 buildings
- North-south tunnel west of F&I 1 that serves the west primary Parshall flumes
- East-west tunnel along 5th Avenue
- North-south tunnel that divides the west primary tankage

The following tunnels would require demolition, or demolition and relocation, to construct a new solids processing facility at Site 2:

- A narrow tunnel that is located on the north end of West Primary Tanks 4, 5, and 6 serves only these tanks and dewatering beneath them.

- East-west tunnel located between the F&I 1 building and West Primary Tanks 4-6. This tunnel houses solids pumps for all West Primary tanks, gravity thickener overflow piping, electricity, potable water, and piping for



SITE 1 TUNNEL LOCATIONS
MWWTP Solids Processing Improvements
Facility Plan

5-7

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Environmental Services

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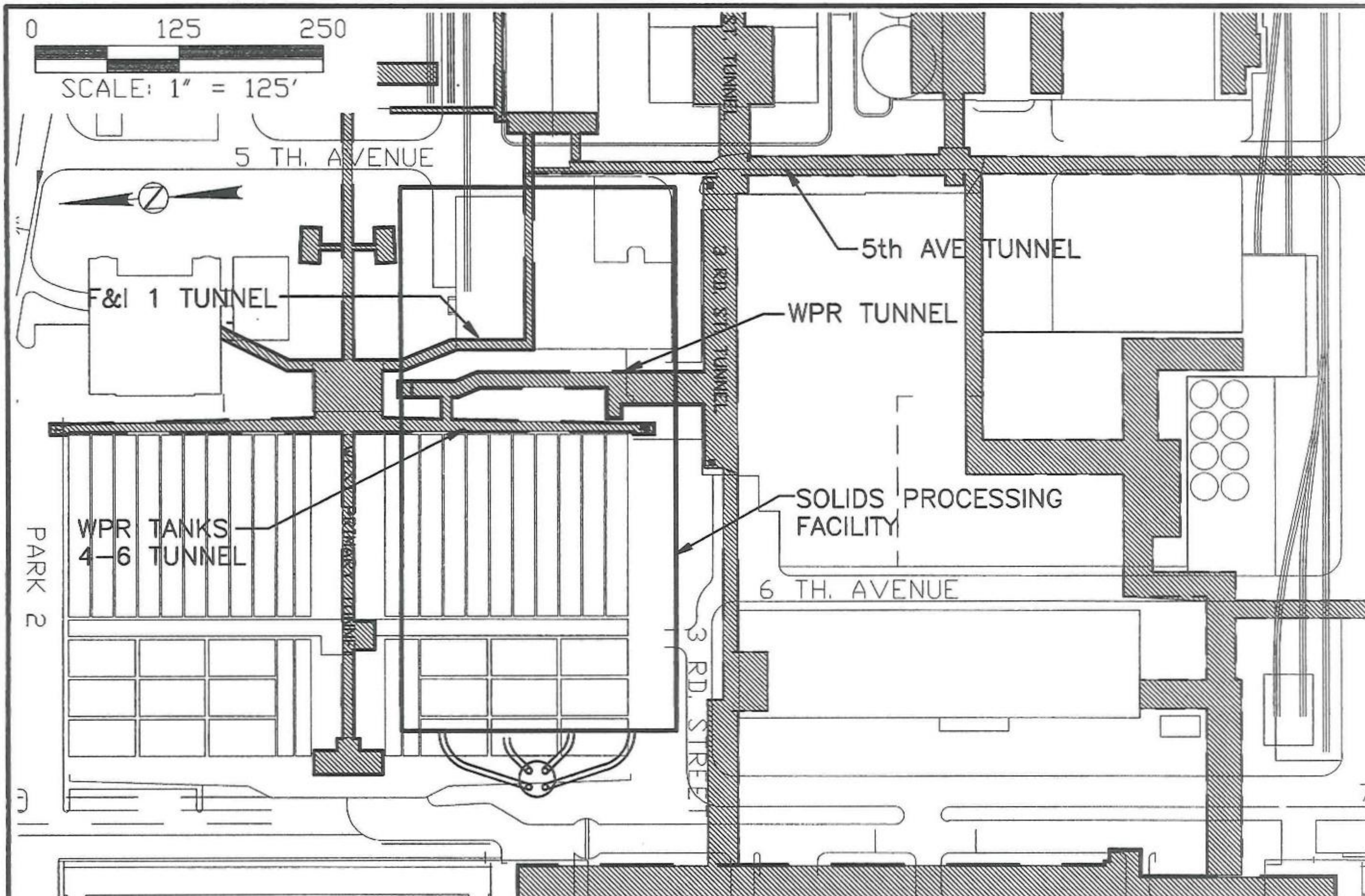

SITE 2 – TUNNEL LOCATIONS
MWWTP Solids Processing Improvements
Facility Plan

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5-8

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many other services. The West Primary tunnel equipment would have to be relocated and the utilities rerouted through a new tunnel.

- The tunnel directly beneath the F&I 1 building that conveys steam heat lines to all buildings north and west of F&I 1. The interruptible and firm natural gas lines enter the entire plant service tunnel system through this tunnel. Power and instrument air lines to the Pump and Blower Building are supplied by the F&I 1 service tunnel. This tunnel and all piping and utilities would require relocation.
- A new tunnel for services from west primary and F&I 1 service tunnel could be located west of the new solids facility.

Non-monetary Evaluation Criteria

The two sites were evaluated based on non-monetary criteria that focused on the characteristics and impacts associated with the two sites. The technologies of incineration and heat drying were not evaluated since both technologies can be implemented at both sites.

The following briefly discusses applicability of each criterion to the two sites.

1. **Staffing Impacts.** No significant difference between the two sites was identified.
2. **Resource Requirements.** Site 1 will require a little additional electricity for pumping solids to the site. However, it is not expected to be significant.
3. **Space Impacts.** Site 1 limits east expansion of the east primaries. Site 2 limits future expansion of aeration tanks. There are currently no expansions planned for areas adjacent to either site within the planning period, or to the year 2025.
4. **Environmental Impacts and Architectural/Historical Significance.** Research for Site 1 indicates potential existence of early settlements. Trenches were excavated to assess the potential for buried archaeological sites. The results showed interception of buried soil horizons, which may have the potential to contain cultural materials. Further archaeological investigations may be completed at this site depending upon comments from the State Historical Preservation Officer (SHPO). Identification of early settlement will not preclude use of Site 1.

   The F&I 1 Building was assessed for architectural and historic significance. The opinion of the reviewer, to be confirmed by the SHPO, was that the historic integrity of the plant has been compromised by alterations and does not appear to have historic or architectural significance.

   Other Environmental Issues:

   - The vegetation on both sites consists of turfgrass and non-native species growing on disturbed ground.
   - No direct impacts to wetlands is expected for either site.
   - No significant difference in visual impacts for the two sites was identified.

- Construction activities and the facilities will be located within the existing floodwall and levee system.

5. **Residuals.** There was no significant difference identified between the two sites.
6. **Flexibility.** Since space at Site 1 is less constrained than at Site 2, Site 1 would have more flexibility for future expansion.
7. **Reliability.** No difference between the two sites was identified.
8. **Operability.** If dewatering equipment is located in the same building as solids processing equipment, which is recommended, then no difference in operability between the two sites was identified.
9. **Maintainability.** Comments from No. 8 apply.
10. **Safety.** Safety during construction at Site 2 may be a concern, but is short in duration.
11. **Implementation (Permitting).** No difference between the sites was identified. Future decisions by FAA or MPCA may result in identification of permit issues.
12. **Sustainability.** No difference between the sites was identified.
13. **FAA Approach Zone.** Both sites are within FAA approach zones for Holman Field. Site 2 is between two approaches, and Site 1 is located on the edge of one approach. Site 1 shows a slight advantage since it is a greater distance from the approach runway than Site 2.
14. **Solids Pumping/Conveyance.** Site 1 would require new facilities to pump solids to the site from the primary solids storage tanks, secondary solids holding tanks, and/or the flotation thickeners.

    Site 2 has solids piping to the adjacent F&I 2 building and would require extensions to serve the new solids facility.

15. **Tunnel System.** Site 1 would require extension of an existing tunnel from the East Primary, or Flotation Thickener area to connect to the tunnel system.

    Multiple tunnels currently exist on Site 2. Utilizing this area for the new solids processing facility would require extensive relocation of tunnels and the piping and utilities located in those tunnels.

16. **Constructability/Sequencing/Impact on Operations.** Site 1 is located on the edge of the plant, adjacent to an access road that encircles the plant. A new facility could be constructed at this site with little impact on current operations.

    Site 2 has space constraints that will significantly limit contractor access, staging, maneuverability and constructability. Since this site contains existing structures, piping, and utilities; operations would be impacted as these systems are disconnected and rerouted.

17. **Power Connection.** Both sites would require a new substation. Site 1 will require new conduit bank installation from south of the site.

18. **Structural Issues.** Pile length is estimated to be 100 feet and 50 feet at Sites 1 and 2, respectively. The pile length differences are reflected in foundation costs.

19. **Truck Access for Ash, Alkaline Stabilized, or Dried Product.** Site 1 has access on the perimeter of the plant.

    Site 2 will require truck access through the center of the plant for delivery of chemicals and removal of products.

20. **Project Delivery.** Site 1 is a better location for a private ownership or operation option.

Comparative Capital Costs

Comparative capital costs were developed for heat dryer and FBI technologies located at both Sites 1 and 2. The costs were based on system component costs that varied due to site characteristics and Metro Plant Master Plan costs. These costs were updated to reflect revised building dimensions or other modifications from the Metro Plant Master Plan concept. Unit costs were generally based upon Master Plan unit costs where applicable. These comparative costs are estimated to fall within an accuracy range of 15 to 20 percent.

A summary of the costs is shown on Table 5-1. The costs shown are siting-related costs only and do not include equipment. These costs can be used to compare siting costs, but not to compare costs for the two technologies.

Evaluation of Alternative Sites

A task force of MCES personnel reviewed the non-monetary criteria and capital costs. The sites were ranked on non-monetary criteria using a process by which each criterion was weighted on a scale of 1 to 5 (5 being high). A weighted score was determined by multiplying the weighting by the rating. The weighted scores were totaled for each site for comparison. The total scores show that Site 1 has an advantage over Site 2 on the basis of non-monetary criteria. Table 5-2 shows a summary of the results of the ranking process.

Comparison of capital costs for the two sites, not the technologies, showed that the two sites were equivalent within the accuracy of estimation. Neither site shows a strong advantage on the basis of comparative capital costs.

Table 5-1
COMPARATIVE CAPITAL COST BY SITE AND TECHNOLOGY

	DESCRIPTION	INCINERATION Site 1 NE Site	INCINERATION Site 2 F&I1/WPR	DRYING Site 1 NE Site	DRYING Site 2 F&I1/WPR	SOURCE OF COST DATA
DEMOLITION						
	F&I1	-	$1,300,000	-	$1,300,000	MP unit cost of $10/sf wall demo cost applied to actual dimensions
	F&I1 to Grade	$1,300,000	-	$1,300,000	-	MP unit cost of $10/sf wall demo cost, $20/cy fill - implemented in yr 2006
	WPR-East Bank	-	$2,200,000	-	$2,200,000	MP unit cost of $15/sf wall demo cost applied to actual dimensions
	F&I1 Tunnel	-	$50,000	-	$50,000	MP unit cost of $15/sf wall demo cost for tunnel not in bldg
	WPR Tunnel	-	$250,000	-	$250,000	MP unit cost of $15/sf wall demo cost applied to actual dimensions
	Tunnel Piping/Utilities	-	$700,000	-	$700,000	Consultant estimate of demolition for actual quantities
	Pole Buildings	$150,000	-	$150,000	-	Consultant estimate
RELOCATION						
	WSG Substation	-	$3,500,000	-	$3,500,000	1984 cost estimate brought up to 1997 $
	Tunnel Piping/Utilities	-	$10,700,000	-	$10,700,000	Consultant estimate based on actual quantities
STRUCTURES						
	Incinerator Building	$43,160,000	$43,160,000	-	-	MP unit cost applied to footoprint of 240 ft x 350 ft, plus 170 ft x 60 ft
	Centrifuge Building	$4,500,000	$4,500,000	$4,500,000	$4,500,000	MP recommended alternative cost
	Alkaline Stabilization	$6,000,000	$6,000,000	$6,000,000	$6,000,000	MP cost backup
	Ash Silos	$3,600,000	-	-	-	
	Dryer Building	-	-	$49,215,000	$49,215,000	MP unit costs applied to footprint of 240 ft x 460 ft
	F&I1 Tunnel	-	$1,260,000	-	$1,260,000	MP unit cost of $4000/lf x 315 lf
	EPR to NE Site Tunnel	$2,200,000	-	$2,200,000	-	MP unit cost of $4000/lf x 550 lf
	Turbine Building	$420,000	$420,000	-	-	MP alternative S10
	Foundation-Dryer or Incin Bldg	$3,960,000	$2,350,000	$4,637,000	$2,760,000	MP unit cost of $42/sf for NE site, $25/sf for F&I1/WPR site
EQUIPMENT						
	Primary Power Transmission	$1,300,000	$350,000	$1,300,000	$350,000	Consultant estimate
	Piping/Pumping to New Site	$6,000,000	-	$6,000,000	-	Consultant estimate
	TOTAL	**$72,590,000**	**$76,740,000**	**$75,302,000**	**$82,785,000**	

Table 5-2
SUMMARY OF NONMONETARY CRITERIA EVALUATION

Description	Weighting of Criteria	Rating of Sites			
		Site 1 NE Site		Site 2 F&I 1/WPR Site	
		Rating	Total	Rating	Total
	1 = low; 5 = high	1 = poor; 5 = good	(weighting x rating)	1 = poor; 5 = good	(weighting x rating)
1. Staffing Impacts	3.25	3.0	9.8	3.0	9.8
2. Resource Requirements	3.25	2.0	6.5	3.0	9.8
3. Space Impacts	3.50	4.0	14.0	3.0	10.5
4. Environmental Impacts	3.50	3.0	10.5	3.5	12.3
5. Residuals	3.25	3.0	9.8	3.0	9.8
6. Flexibility	3.75	4.0	15.0	2.0	7.5
7. Reliability	3.75	3.0	11.3	3.0	11.3
8. Operability	3.75	3.0	11.3	3.0	11.3
9. Maintainability	4.25	3.5	14.9	3.0	12.8
10. Safety	3.75	4.0	15.0	3.0	11.3
11. Implementation (Permitting)	3.75	2.0	7.5	2.0	7.5
12. Sustainability	1.75	3.0	5.3	3.0	5.3
13. FAA Approach Zone	4.00	3.5	14.0	3.0	12.0
14. Sludge Pumping/Conveyance	2.75	2.0	5.5	3.0	8.3
15. Tunnel System	3.00	3.0	9.0	2.0	6.0
16. Constructability/Impact on Operations	3.50	5.0	17.5	2.0	7.0
17. Power Connection	2.00	3.0	6.0	3.0	6.0
18. Structural Issues	3.25	3.0	9.8	3.0	9.8
19. Truck Access for Ash, alkaline stabilized or dried product	3.75	3.5	13.1	3.0	11.3
20. Project Delivery	2.00	3.0	6.0	2.0	4.0
Total Nonmonetary Impacts			**211.5**		**183.0**

Section 6
Alternative Evaluation

Overview

This section presents a detailed evaluation of the Metro Plant Solids Processing Improvement Project solids stabilization alternatives studied between November 7, 1997, and July 23, 1998. The evaluation is based on monetary and non-monetary factors. Refinements to the selected alternative completed after July 23, 1998, are not included in this section, but are incorporated in Section 3 – Recommended Alternative.

Project Background

The Metro Plant Master Plan (December 1996) evaluated projected wastewater quantities, projected residual solids quantities to the year 2040, and the capacity and condition of existing solids processing facilities. The evaluation concluded that the existing solids processing facilities had adequate treatment capacity, but that the remaining useful life of the facilities was approximately 10 years with increasingly greater maintenance costs. Implementation of a new solids stabilization/processing facility by the year 2005 was a priority recommendation.

Alternative Technologies

Twelve solids processing alternatives were evaluated in the Metro Master Plan, and included variations of the following five conventional solids stabilization technologies:

- Anaerobic digestion
- Fluid bed incineration
- Heat drying
- Alkaline stabilization
- Composting

Following the work of the Metro Plant Master Plan, two alternative technologies for stabilization of solids were selected for additional evaluation: fluid bed incineration and heat drying. Following the initial evaluation between fluid bed incineration and heat drying (Evaluation of Alternative Technologies for Solids Handling at the Metro Plant, January 1998), the Council requested that an analysis be completed for anaerobic digestion and alkaline stabilization and be included in the Facility Plan alternative evaluation.

This section includes the following information for each of the stabilization alternatives evaluated:

- Summary of projected solids quantities
- Description of the alternatives evaluated

- Discussion of air emissions, including identification of pollutants of concern and air pollution control technologies for each alternative
- Discussion of beneficial reuse of residuals for each alternative
- Evaluation of monetary and non-monetary factors for each alternative
- Conclusions and recommendation

Solids Quantities

Wastewater load projections and projections for solids hauled to the Metro Plant from other MCES facilities were used to develop wastewater solids quantities for evaluation of alternative technologies. Further information on development of wastewater solids projections is included in Section 9 – Flows and Loads.

Facilities sizing was based on year 2040 solids loadings reported in the Metro Plant Master Plan, and life-cycle costs were developed using a 20-year planning period (2005 to 2025).

Descriptions of Alternative Technologies

Application of the four alternative technologies (fluid bed incineration, heat drying, anaerobic digestion, and alkaline stabilization) has resulted in the development of six alternative treatment systems. These alternatives are briefly defined as follows:

- **Alternative 1.** Four fluid bed incinerators (FBIs)
- **Alternative 2.** Three FBIs with supplemental alkaline stabilization for peak and downtime loading
- **Alternative 3.** Heat drying that produces a low nitrogen product with supplemental alkaline stabilization for peak and downtime loading
- **Alternative 4.** Heat drying that produces a high nitrogen, high quality product, with anaerobic digestion of excess primary solids
- **Alternative 5.** Anaerobic digestion with cake storage
- **Alternative 6.** Alkaline stabilization

Detailed descriptions of the alternatives follow. Common features of the alternatives are referenced rather than repeated. In addition to these alternatives, an evaluation for rehabilitating the existing multiple hearth incinerators and an evaluation of supplemental technologies to produce biosolids for agriculture were completed.

Alternative 1: Fluid Bed Incineration with Four Incinerators

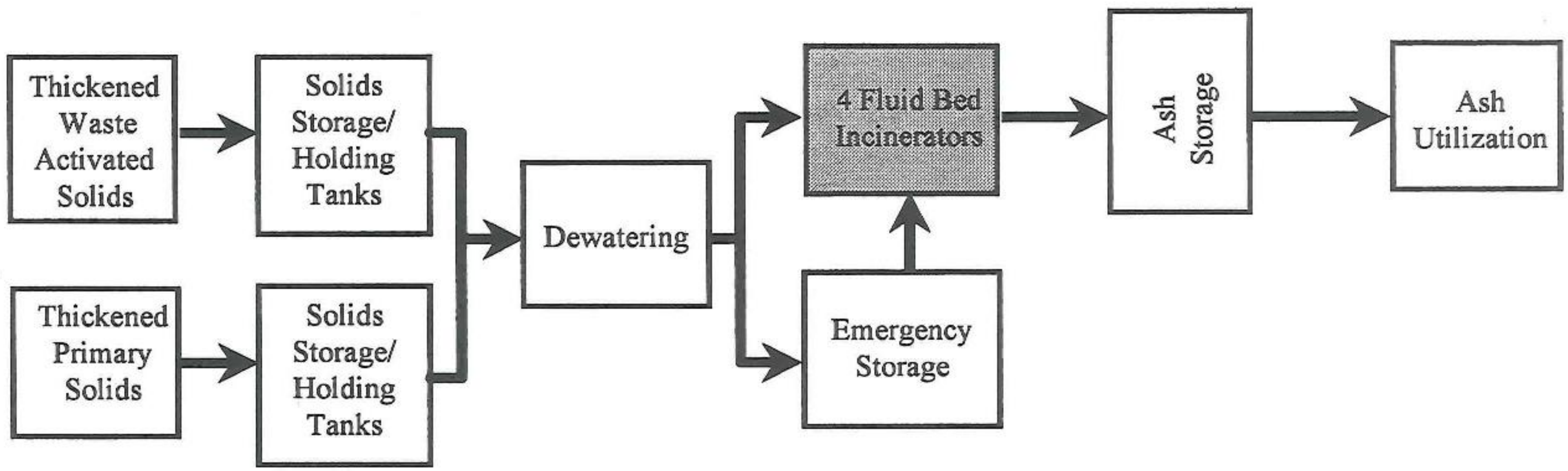
All of the solids produced at the Metro Plant will be incinerated in four FBIs. The process flow is illustrated in the solids processing block diagram on Figure 6-1. Centrifuges dewater thickened primary and thickened waste activated solids to produce a solids cake having an average of 30 percent dry solids (range 27 to 32 percent). The dewatered cake is incinerated in FBIs to produce residual ash and clean exhaust gases, which are discharged into the atmosphere. The ash is stored on site prior to reuse off site.

General

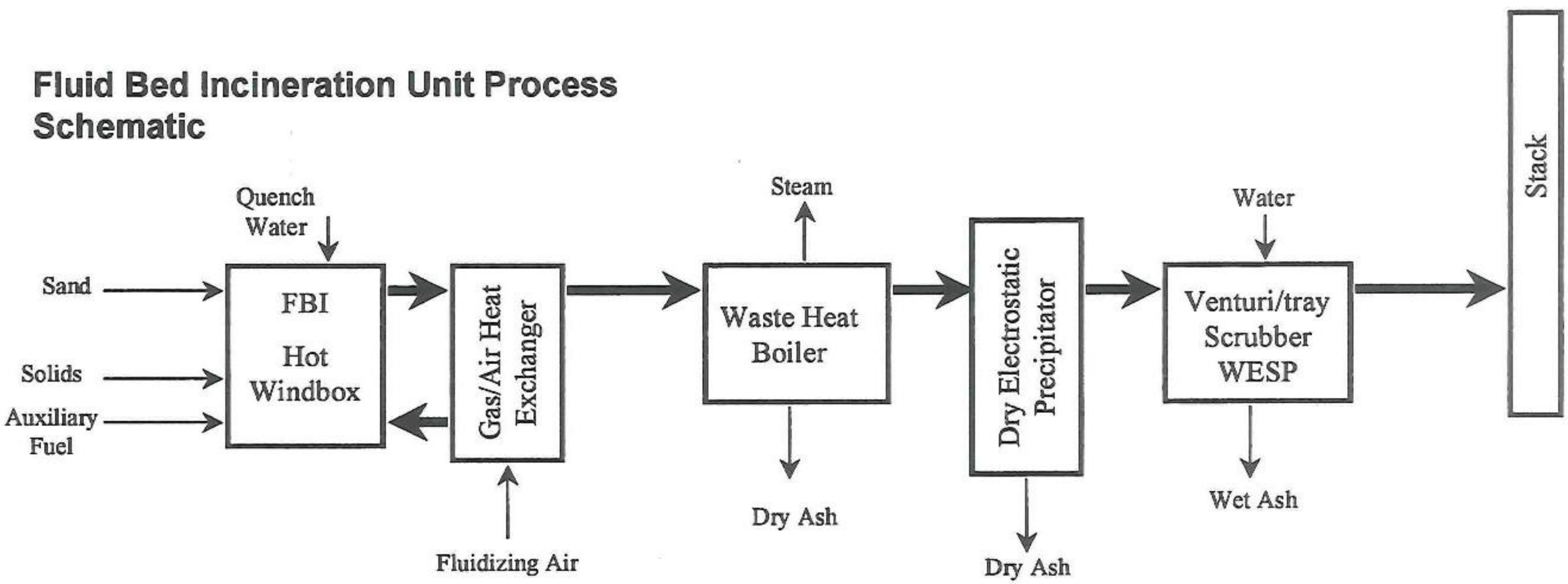
The dewatering system consists of eight centrifuges, each capable of treating 220 gpm of solids. Based on the annual average solids production in 2005, between

Figure 6-1
4 Fluid Bed Incinerators (Alternative 1)

Solids Processing Block Diagram



Fluid Bed Incineration Unit Process Schematic



four and five centrifuges will operate continuously, and seven will be required to handle the 2040 peak week operation. The FBI system consists of four equipment trains, each capable of incinerating 105 dry tons per day (dtpd) of dewatered solids cake. Based on annual average solids production in 2005, three FBIs will operate, with four operating to handle the 2040 peak week. A dewatered solids load-out and load-in facility is included for emergency conditions when more than one incinerator may be out of service and solids production exceeds operating incinerator capacity. This facility provides capacity for the Metro Plant to comply with effluent permit requirements without having full incineration capacity continuously available.

Each FBI system consists of a hot windbox FBI, a waste heat boiler, and air pollution control equipment, together with a stack. The FBI consists of a steel cylinder lined with refractory material to protect the steel from heat and abrasion. The FBI has three distinct internal zones:

1. The windbox, located at the bottom of the FBI, provides a chamber for distribution of fluidizing air into the fluidizing zone.

2. The fluidizing zone, which contains a sand bed, is separated from the windbox by an air distribution plate. The sand is fluidized by the fluidizing air, which provides the turbulence necessary to assist efficient combustion. The sand provides a source of heat to ignite the solids particles and remove heat from the solids flame, and assists in stabilizing combustion. The sand also helps to break the solids particles into smaller particles. In addition, the sand bed stores heat when the FBI is shut down, allowing shutdowns of up to 2 days without having to reheat the FBI to restart combustion.

3. The freeboard, which is the zone above the fluidized bed, provides sufficient residence time for the combustion to be completed. It also allows sand and larger solids particles to disengage from the combustion zone and fall back into the fluidized bed. The hot combustion gases or off-gases, together with fine ash, exits the top of the freeboard.

The temperature range in the fluidizing zone is typically 1,350 to 1,450°F, whereas the freeboard temperature range is typically 1,500 to 1,550°F. The fluidized bed and freeboard zones act as afterburners because of the bed and freeboard temperatures and the long residence times (5 to 7 seconds) in the freeboard. Heat is recovered from the hot off-gases and can be used to preheat the fluidizing air and/or produce steam. If the combustion air is preheated, as in the Metro Plant's circumstance, a gas-to-air heat exchanger is provided at the outlet of the freeboard. A fluidizing air blower compresses the fluidizing air and conveys it through the heat exchanger and into the windbox. Preheating fluidizing air reduces the need for auxiliary fuel.

The waste heat recovery boiler cools the off-gases and converts the heat to steam. The air pollution control equipment removes particulates, heavy metals, and acid gases from the off-gases.

Facility Location and Layout

As shown on Figure 6-2, Alternative 1 would be located at the northeast corner of the site, adjacent to the primary tanks. The building occupies about 110,000 square feet. A common stack on the north of the building exhausts the off-gases to the atmosphere. The stack height exceeds 100 feet and approaches the maximum height allowed by the St. Paul Airport. The building is connected to the existing plant via the primary tank tunnel that provides space for solids piping and utilities.

Alternative 2: Three Fluid Bed Incinerators with Alkaline Stabilization

This alternative provides a similar FBI system as detailed in Alternative 1, except that only three FBI trains are included and the building footprint is reduced by approximately 25 percent. In addition, supplemental alkaline stabilization is provided for peak operating conditions and during maintenance as shown on Figure 6-3.

General

Three FBI trains reduce the incineration system capacity by 105 dtpd and supplemental solids stabilization capacity is required. With only three incinerators and the recognition that units need to be removed from service for maintenance, the incineration capacity with one unit out of service is less than the projected average solids production quantities by 42 and 75 dtpd in the years 2005 and 2040, respectively. In addition, with all three FBI trains in operation, incineration capacity is less than the projected maximum week loadings by 26 and 61 dtpd in the years 2005 and 2040, respectively. Therefore, alkaline stabilization capacity is provided to supplement the FBI capacity and provide sufficient stabilization capacity to meet all projected operating conditions.

Alkaline stabilization facilities include:

- Two 30,000-cubic-feet lime storage silos
- Three mechanical pug mill mixers (one unit is redundant) to mix the dewatered solids and the alkaline additive
- Solids conveyors
- Two live bottom bins to continuously receive the alkaline and solids mixture and intermittently load trucks for storage and transportation of the product

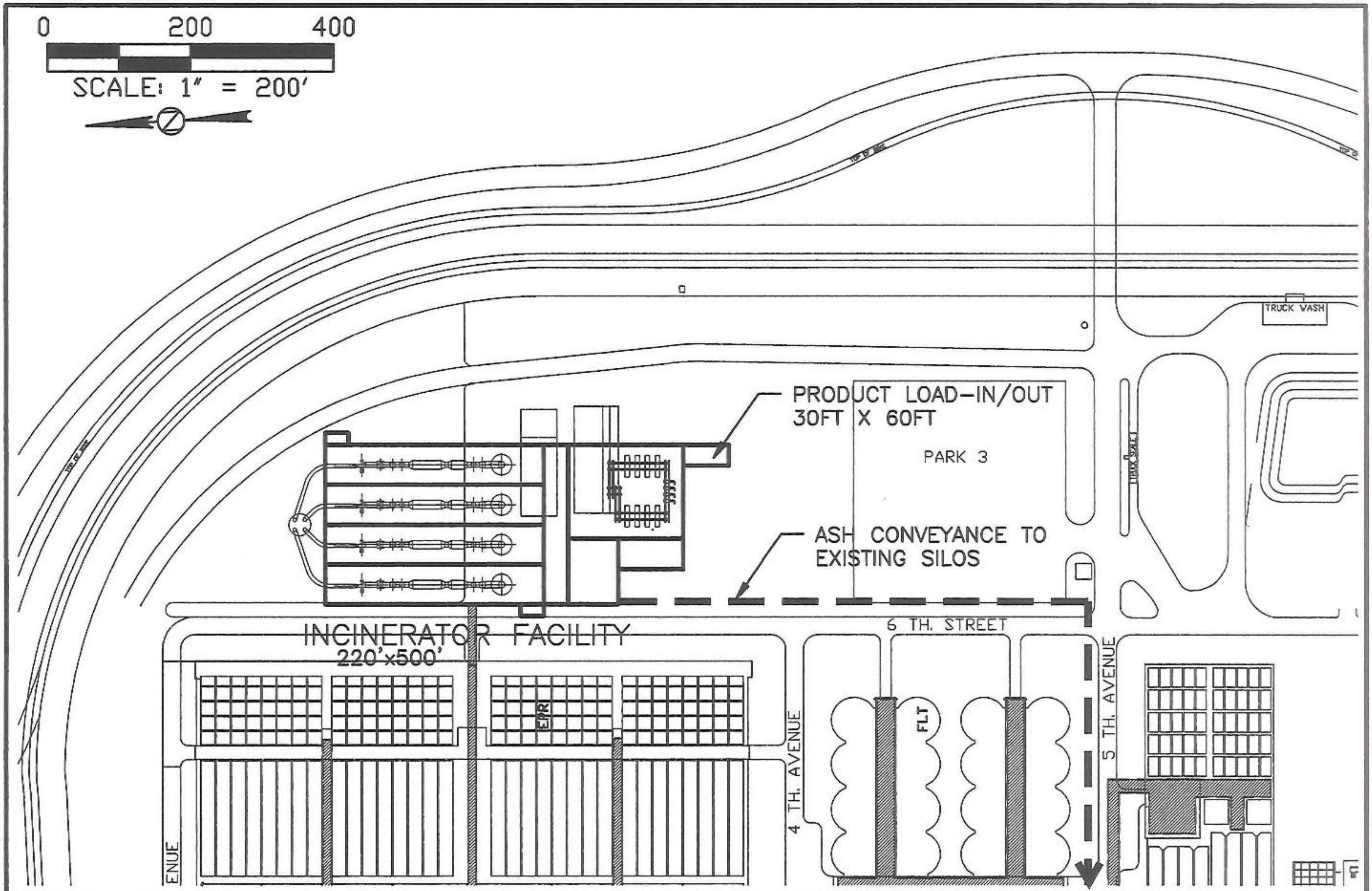
Facility Location and Layout

As shown on Figure 6-4, Alternative 2 would be located at the northeast corner of the site adjacent to the East Primary tanks. The building occupies about 83,000 square feet, excluding lime and alkaline product storage. A common stack on the north end of the building will exhausts the off-gases to the atmosphere. The stack height exceeds 100 feet and approaches the maximum height allowed by the St. Paul Airport. The alkaline stabilization facility would be adjacent to the FBI facility and includes two 26-foot diameter lime storage silos and a 3,600-square-foot alkaline product loadout building. The building is connected to the existing plant via the primary tank tunnel that provides space for solids piping and utilities.

Alternative Locations

Installation of Fluid Bed Incinerators in the Existing Incineration Building

An alternative configuration was identified that includes installation of FBIs in the existing incineration building. Initially, this option was anticipated to be less costly than installing the FBIs in a new building due to savings in construction



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FOUR FLUID BED INCINERATORS (ALTERNATIVE 1)

Figure 6-2

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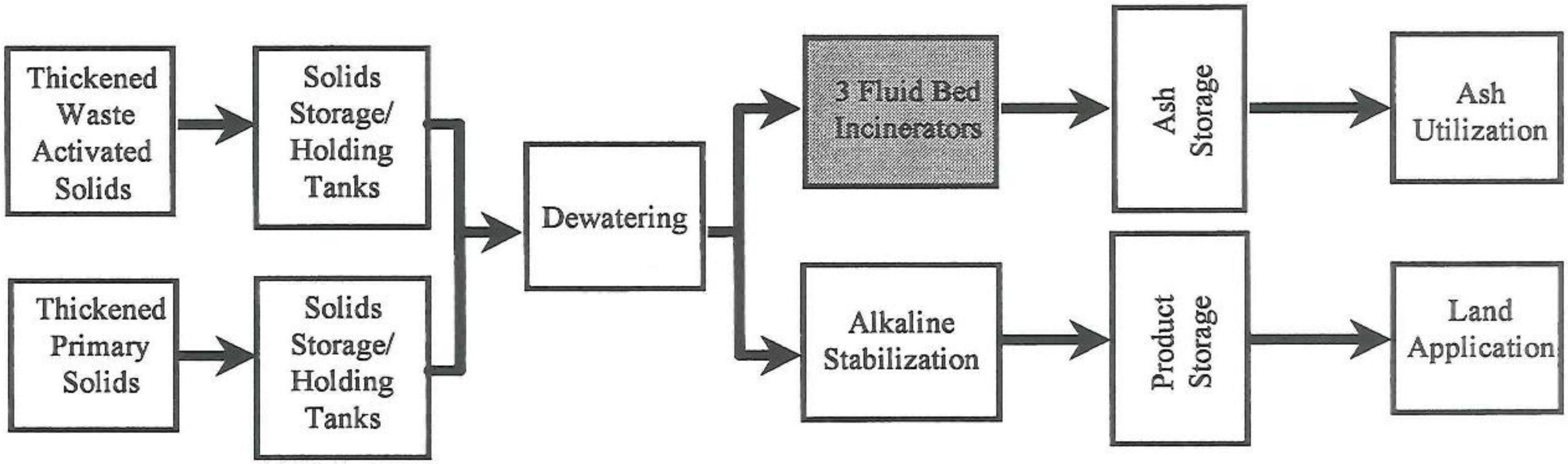
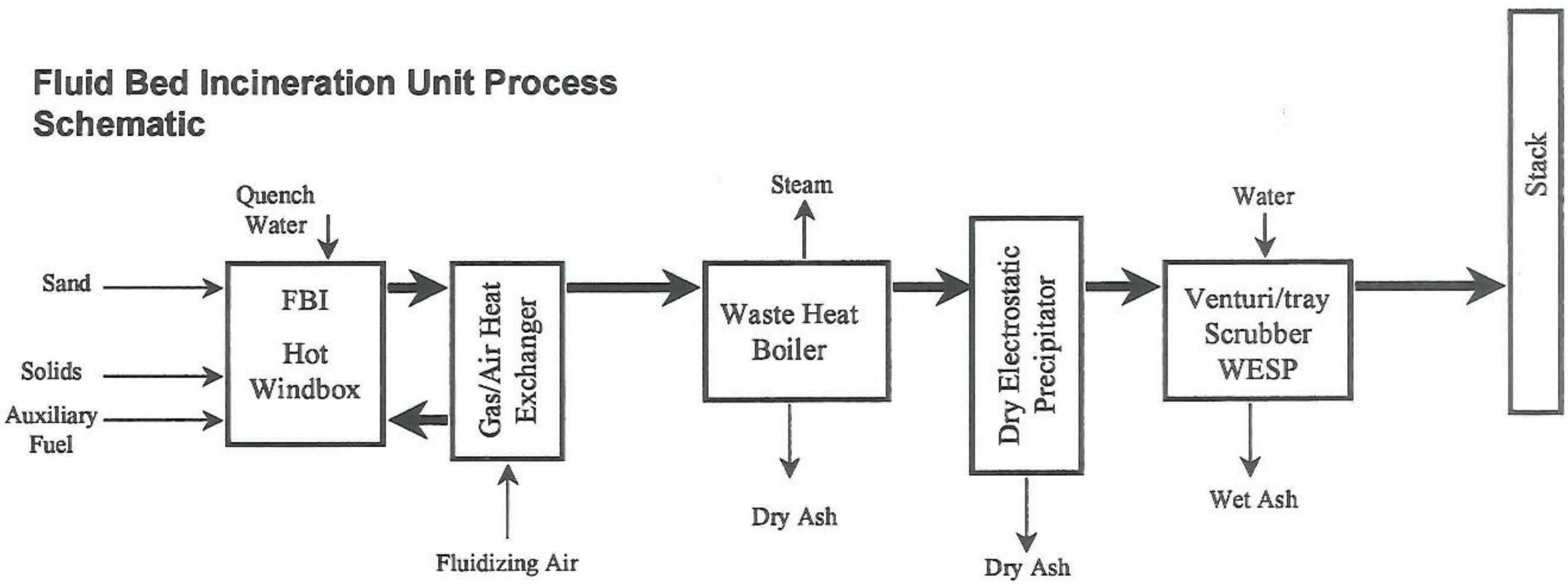
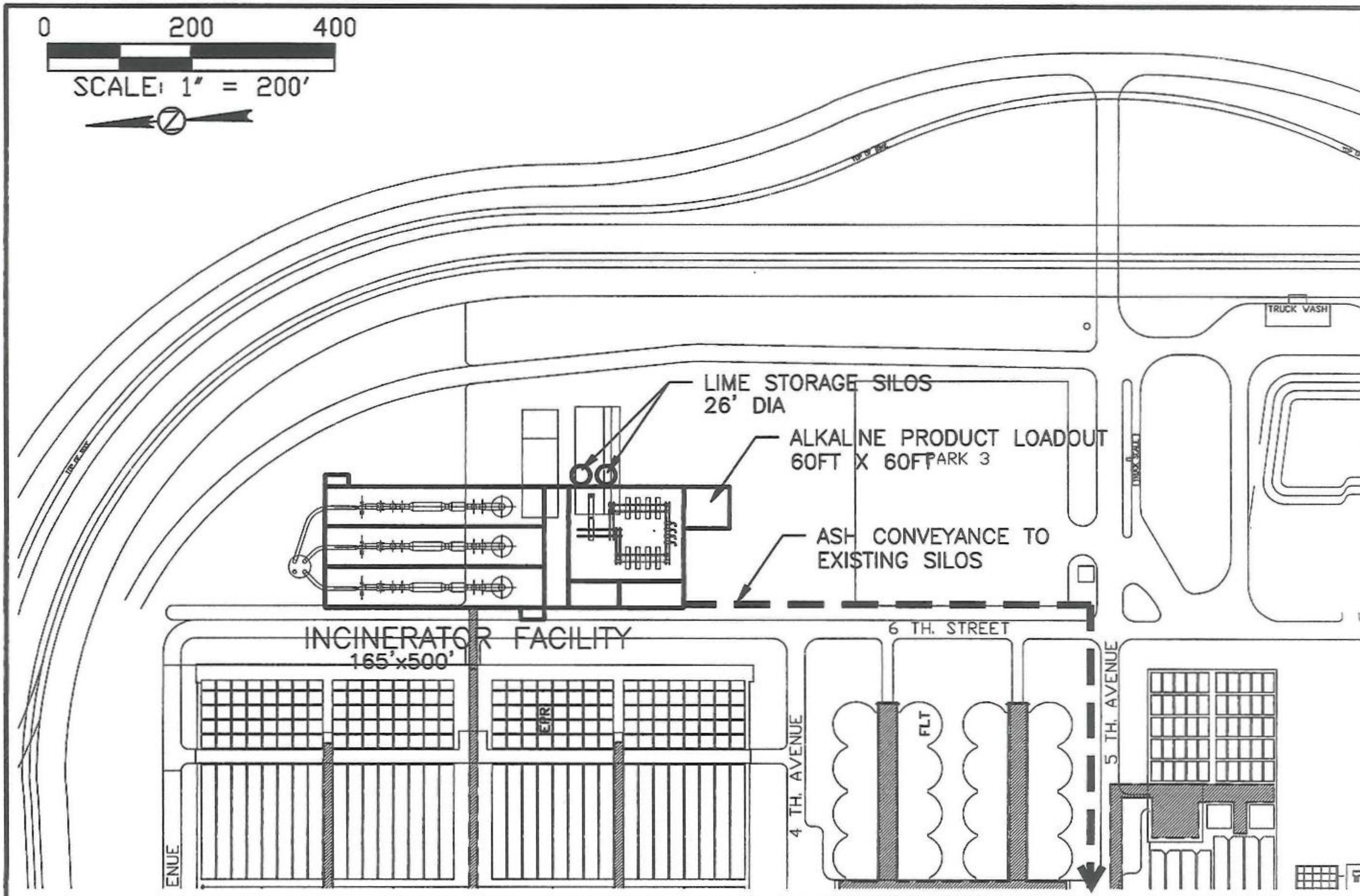
Figure 6-3
3 Fluid Bed Incinerators (Alternative 2)

Solids Processing Block Diagram



Fluid Bed Incineration Unit Process Schematic





Metropolitan Council
Environmental Services

THREE FLUID BED INCINERATORS (ALTERNATIVE 2)
WITH ALKALINE STABILIZATION

Figure 6–4

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costs. However, the existing building is not readily adaptable to the proposed equipment as summarized below:

- The structural frame has moment connections that would present significant structural problems when removing a beam to install the new equipment.
- The building design was tailored to the existing equipment in the building and would require significant structural revisions to accommodate the proposed equipment.
- The openings for the multiple hearth incinerators would require the proposed FBIs to be reduced in capacity from 105 dtpd to approximately 87 dtpd. The cost of the smaller equipment would be nearly double if installed in the existing building.
- Installing the new equipment would disrupt current facilities that need to maintain operation, such as the control room, the plant process air system and the primary scum concentration facilities.

Based on the above issues, reuse of the existing incineration facilities for the FBIs is not a viable alternative.

Installation of Fluid Bed Incinerators in the Existing Abandoned F&I 1 Building
Initially, this site was evaluated and not selected for location of the new solids facilities as reported in Section 5 – Solids Facility Location Analysis. However, it was re-evaluated with the incineration and air pollution control train oriented in an east-west direction versus the north-south direction previously considered. It was concluded that the alignment of the incinerators in the east-west direction would require demolition of the emergency stacks for the existing multiple hearth incinerators and would impact the air supply to the F&I 2 building. Also, the F&I 1 building is not wide enough to accommodate three parallel FBI trains. Therefore, the F&I 1 building would require demolition before construction of a new wider structure. The cost of this demolition and the impacts on the existing tunnels resulted in this alternative being eliminated from additional evaluation.

Alternative 3: Heat Drying – Low Nitrogen Product

With Alternative 3, all of the primary and excess secondary solids produced at the Metro Plant are heat dried to produce a pelleted product, which can be used as a soil amendment. The material is termed a low nitrogen product (approximately 4.5 percent), because the primary solids, which make up approximately 60 percent of the solids feed, have a lower nitrogen content than the waste activated solids. In addition, because of the high percentage of primary solids in the product, the dried product will contain fiber, generate dust, and emit odors, especially when wet. This low nitrogen product will not result in a premium dried biosolid product like Milwaukee's Miloganite™, which is recognized as a premium dried biosolids product in the market place. Milorganite™ is manufactured from a combination of primary and waste activated solids, with the primary solids component not exceeding 30 percent of the total. Milwaukee is able to effectively control primary and waste activated solids ratios by pumping solids through a force main between their two main treatment plants to achieve the desired ratio. Milorganite™ has a higher nitrogen content and is dust and odor free.

General

The process flow is illustrated in the solids processing block diagram on Figure 6-5. Thickened primary and thickened waste activated solids are dewatered by centrifuges to produce a solids cake having an average of 30 percent dry solids (range 27–32 percent). The dewatered cake is heat dried in direct heated rotary dryers to produce the pellets and exhaust gases, which are cleaned and discharged into the atmosphere. The product is stored on site prior to beneficial reuse off site.

The dewatering system consists of eight centrifuges, each capable of treating 220 gpm of solids. Based on the annual average solids production in 2005, between four and five centrifuges will operate continuously, and seven will be required to handle the 2040 peak week operation. The heat drying system consists of six equipment trains, each capable of heat drying 58 dtpd of solids cake. Based on annual average solids production in 2005, between four and five dryers will operate continuously.

Each heat dryer system consists of a furnace, a rotary drum dryer, a product separator, an off-gas recycling system, and an off-gas cleaning system. Thermal drying systems have additional equipment for cooling, classifying, handling, and storing the dried product.

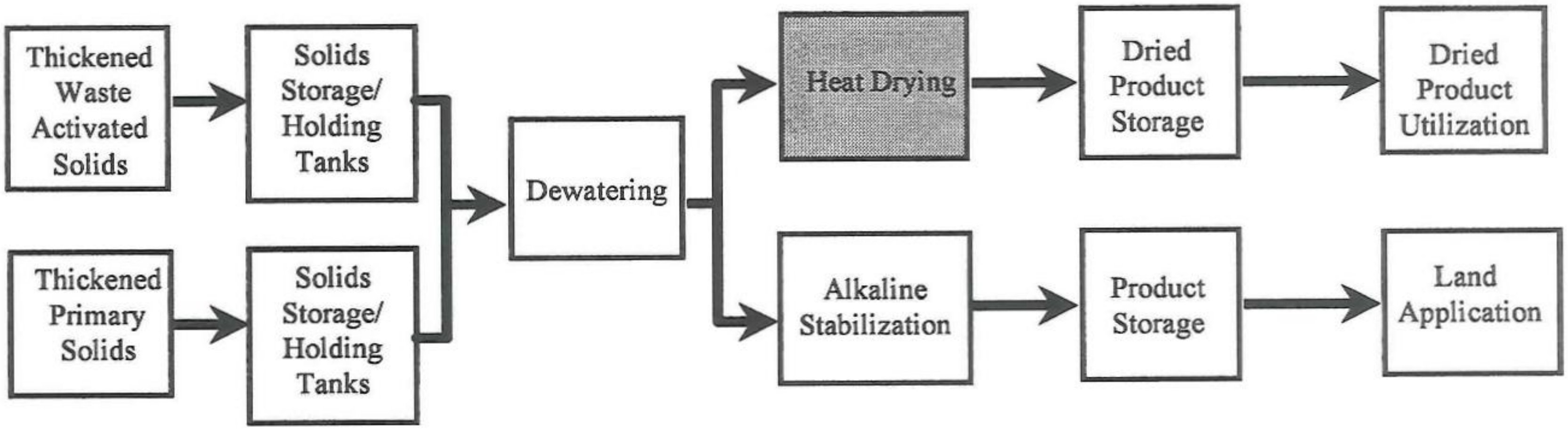
The direct type of dryer consists of a rotary dryer (kiln), usually of the multi-pass type. Air is heated in a combustion chamber, ahead of the dryer, to 700 to 900°F. A mixture of dewatered solids and recycled dried solids enters one end of the dryer with the hot air. The hot air heats the solids to evaporate water. The hot air also conveys the solids through the dryer as it absorbs moisture from the solids. Solids are usually dried to about 95 percent solids and exit the dryer at temperatures ranging from 140°F to 200°F. The air and dried solids pass through a cyclone separator, where the pellets are separated from the air. Most of the air (80 to 85 percent) is returned to the dryer. The rest of the air is cleaned by the air pollution control equipment before being discharged to the atmosphere.

Pelleted biosolids product separated from the dryer off-gases contains fine materials, as well as oversized material. The material is classified by mechanical screening. Pellets of the correct size are sent to storage or to the recycle bin. The fine materials are sent to a recycle bin and the oversized fraction is crushed and then sent to the recycle bin. Material from the recycle bin is mixed with the incoming solids to form pellets, prior to drying.

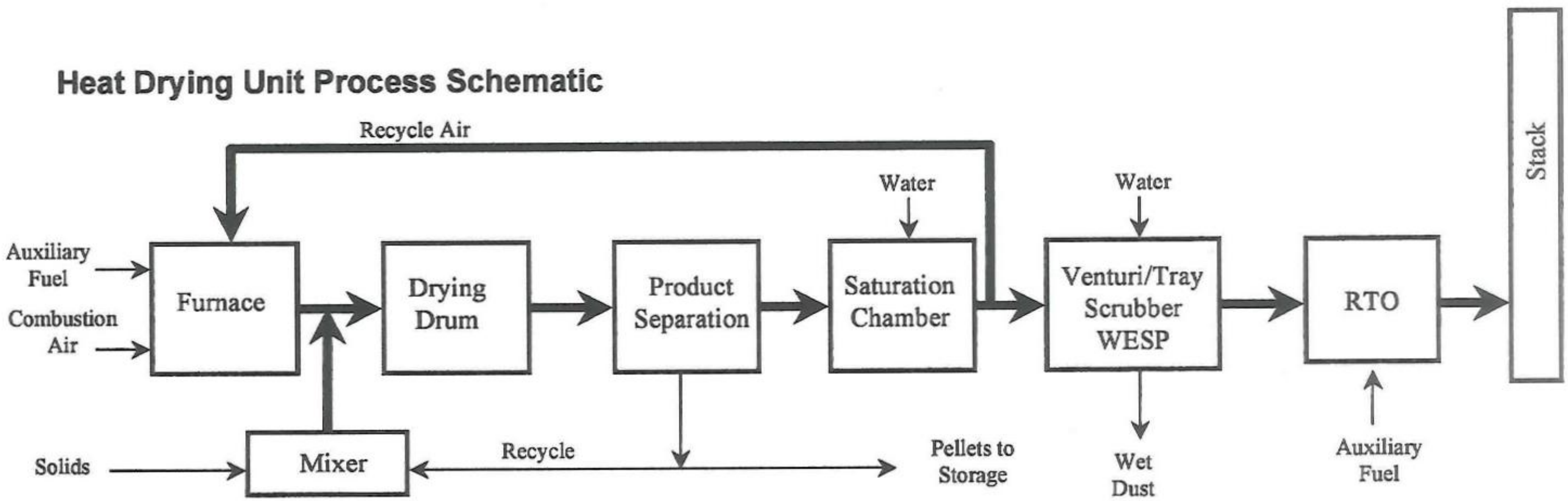
Pellets are cooled in pellet coolers prior to storage for up to 45 days. Pellets are pneumatically conveyed to product silos for storage. The silo complex includes a loadout facility to automatically load trucks. Product silos are equipped with nitrogen blanket systems to control potential fires in the silos that could be caused by spontaneous combustion of the organic fraction of the pellets.

Figure 6-5
Heat Drying-Low Nitrogen Product (Alternative 3)

Solids Processing Block Diagram



Heat Drying Unit Process Schematic



An alkaline stabilization system, comprising two trains, is provided to handle peak week and peak month solids quantities in excess of operating dryer capacity. Six dryers can process 348 dtpd, compared to peak week solids quantities of 376 dtpd projected for the year 2040. Alkaline stabilization facilities are similar to those described in Alternative 2. For this alternative, only one lime silo and two pug mill mixers are included, as use of the facilities will be less than that for Alternative 2.

Facility Location and Layout

As shown on Figure 6-6, the Alternative 3 heat drying facility would be located at the northeast corner of the site adjacent to the East Primary tanks. The building occupies about 58,000 square feet. The pelleted product storage occupies approximately 38,000 square feet. A common stack on the north end of the building exhausts the off-gases to the atmosphere. The building is connected to the existing plant via the primary tank tunnel that provides space for solids piping and utilities. The alkaline stabilization facility would be adjacent to the dryer facility and includes one 26-foot diameter lime storage silo and a 3,600-square-foot alkaline product loadout building.

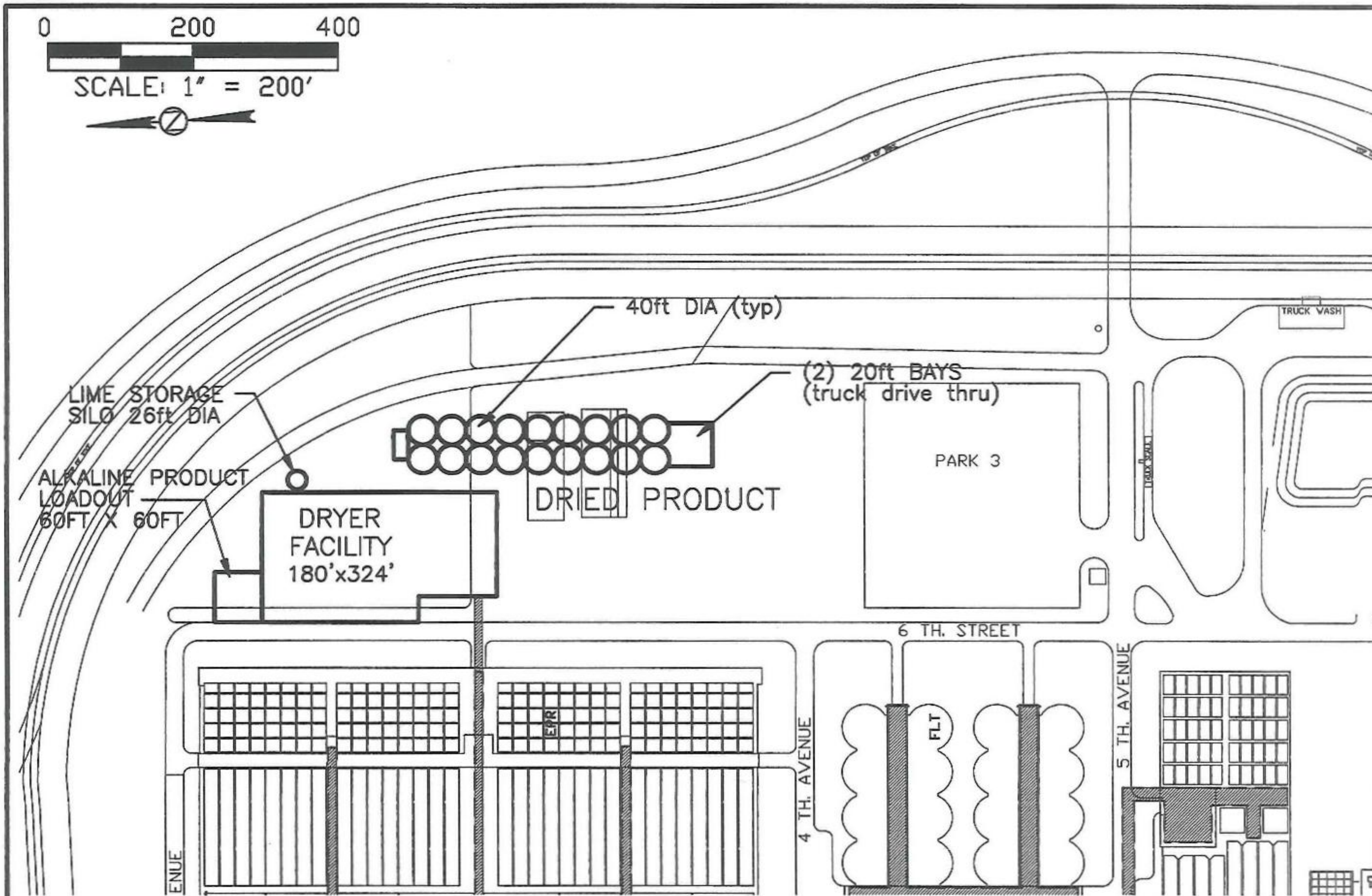
Alternative 4: Heat Drying/Anaerobic Digestion

In Alternative 4, thickened waste activated solids are blended with a portion of the primary solids in a 70:30 blend and heat dried to produce a pelleted quality product. Residual primary solids are anaerobically digested, stored in thickened liquid form, and applied to agricultural land seasonally. Both materials can be used as a soil amendment. The heat-dried material is termed a quality product. The pellets have relatively high nitrogen content (approximately 5.5 percent), due to the higher proportion of waste activated solids in the pellet, reduced odor potential, and less fiber. This product is similar to the Milorganite™ product discussed in Alternative 3.

General

The process flow is illustrated in the solids processing block diagram on Figure 6-7. A blend of thickened waste activated and thickened primary solids (70:30) is dewatered by centrifuges to produce a cake having an average of 27 percent dry solids (range 25 to 30 percent). The dewatered cake is heat dried in direct heated rotary dryers to produce the pellets and clean exhaust gases, which are discharged into the atmosphere. The drying process and handling of the dried product are similar to the procedures described in Alternative 3. The heat drying system consists of four equipment trains, each capable of heat drying 58 dtpd of solids cake. Based on annual average solids production in 2005, up to three dryers will operate continuously, with four required for 2040 peak week operation. The quality dried product is stored on site prior to beneficial reuse off site. Because of the product quality and slow nitrogen release features, a portion of the product may be blended with other fertilizer products by fertilizer distributors to produce a specialty product.

The remaining primary solids are digested in anaerobic digesters. The digestion system consists of five anaerobic digesters, 124 feet in diameter with sidewall height of 40 feet, sized to provide 20 days hydraulic retention time (HRT), with one unit out of service for annual average primary solids quantities. The system can provide 13 days HRT during peak week solids production with one unit out of service. The digested solids are thickened from approximately 3 to 9 percent



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HEAT DRYING—LOW NITROGEN PRODUCT (ALTERNATIVE 3)

Figure 6—6

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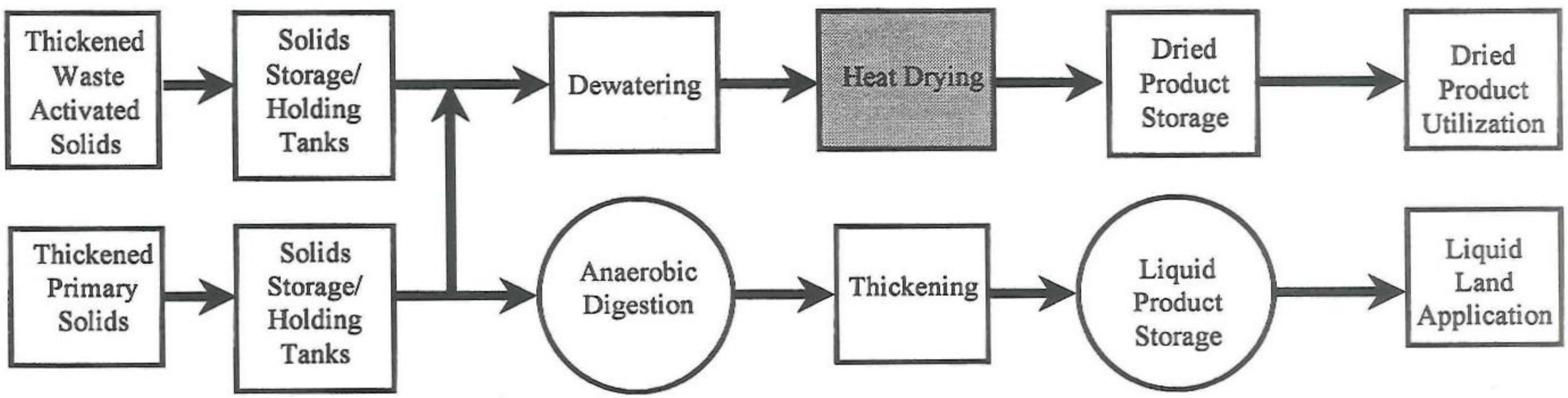
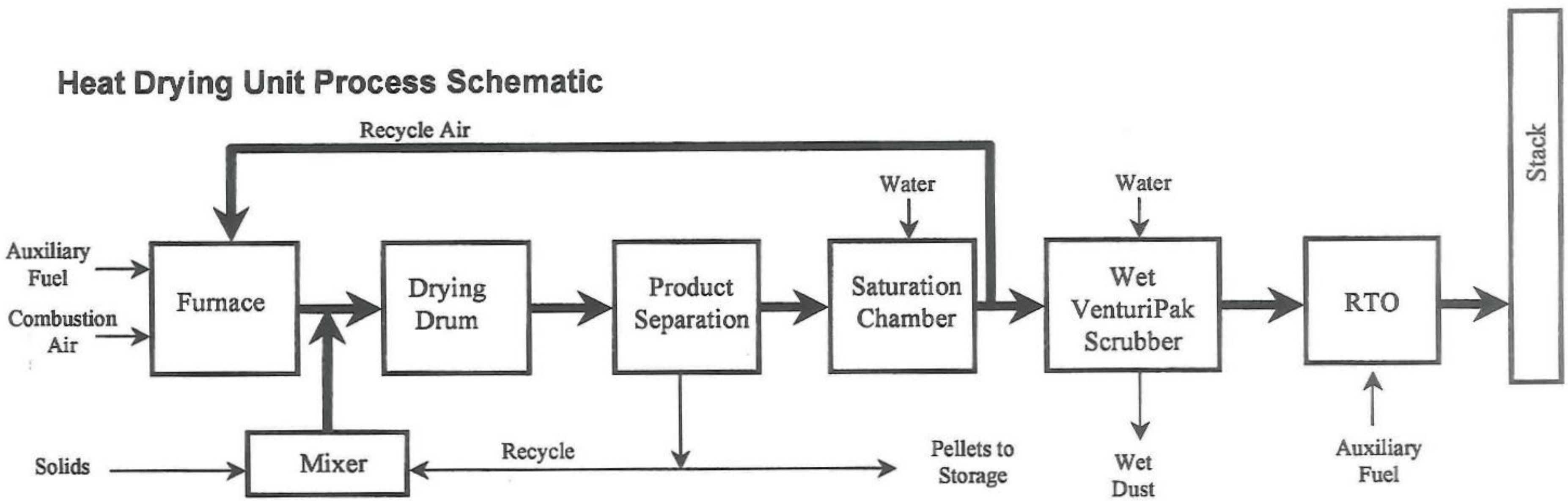
Figure 6-7
Heat Drying/Anaerobic Digestion (Alternative 4)

Solids Processing Block Diagram



Heat Drying Unit Process Schematic



dry solids with centrifuges and stored in covered tanks for up to 180 days, prior to beneficial reuse off site. Beneficial use will include subsurface injection on agricultural land (land spreading), which will require development of a marketing and application program. Methane gas produced during digestion is used as a supplemental fuel for the drying process. The dewatering system consists of six centrifuges, each capable of treating 220 gpm of solids. Based on the annual average solids production in 2005, up to three centrifuges will operate continuously, with four required to handle the 2040 peak week operation.

Facility Location and Layout

As shown on Figure 6-8, the new Alternative 4 drying, digestion, and solids storage facilities would be located at the northeast corner of the site, east of the East Primary tanks. The drying building occupies about 39,000 square feet. The pelleted product storage will occupy approximately 26,000 square feet. A common stack on the north end of the building exhausts the off-gases to the atmosphere. The digestion facilities occupy approximately 240,000 square feet, including digesters, storage, and a tunnel connecting the digesters to the dryers. Liquid solids piping and utilities are routed to the digesters by tunnels and the dryer building. The new solids processing facilities are connected to the existing plant via the primary tank tunnel that provides space for solids piping and utilities.

Alternative Configurations

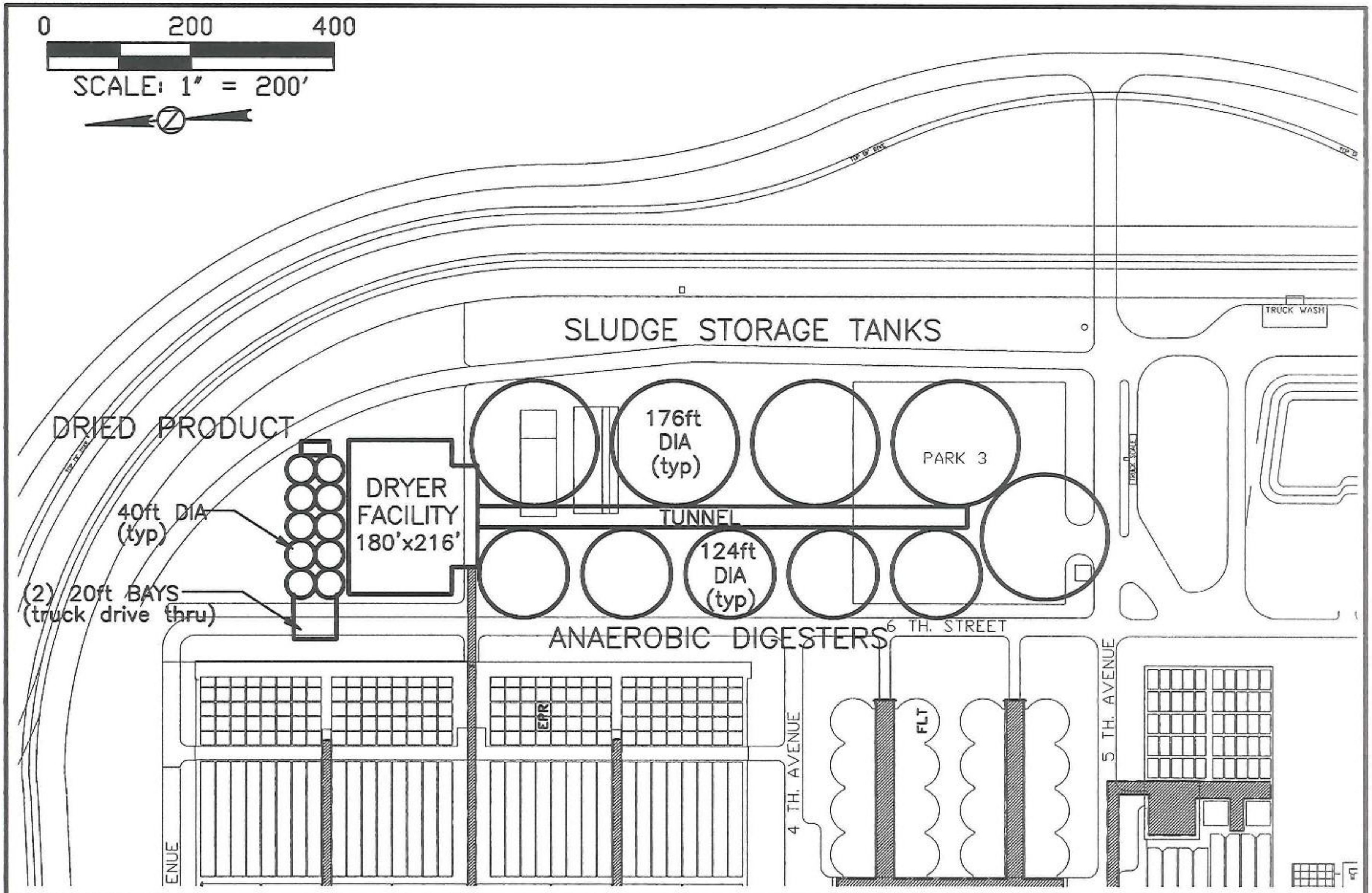
Several configurations of this alternative were identified and evaluated. One possibility was to place the anaerobic digesters and digested biosolids storage tanks in a "silo" configuration with a liquid depth of 80 feet versus 40 feet as used in Alternative 4. This configuration reduced the space requirements but increased the capital costs.

A second possible configuration included dewatering the digested biosolids before storage. This configuration stored the dewatered cake in a covered structure 750 x 143 feet at an average depth of 16 feet. High space requirements, odor concerns, and higher capital costs were associated with this configuration.

Alternative 5: Anaerobic Digestion with Cake Storage

In Alternative 5, gravity thickened primary solids and thickened waste activated solids are fed to anaerobic digesters. Anaerobic digestion destroys 50 percent of the volatile organics in the solids and reduces the pathogen population to levels that will protect the environment when digested biosolids are land applied. Agricultural soils will benefit from the nitrogen, phosphorus, and organic materials in the digested solids.

The process flow diagram for anaerobic digestion is presented on Figure 6-9. Thickened solids are fed to the anaerobic digesters at approximately 6 percent dry solids. The solids are retained in the completely mixed digesters for 15 to 20 days at a temperature of 95° F. Approximately 60 percent of the volatile organics in the feed solids are converted to methane gas, carbon dioxide, and water. The digested biosolids leaving the digesters are more dilute, approximately 3 percent dry solids.



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HEAT DRYING—ANAEROBIC DIGESTION (ALTERNATIVE 4)

Figure 6–8

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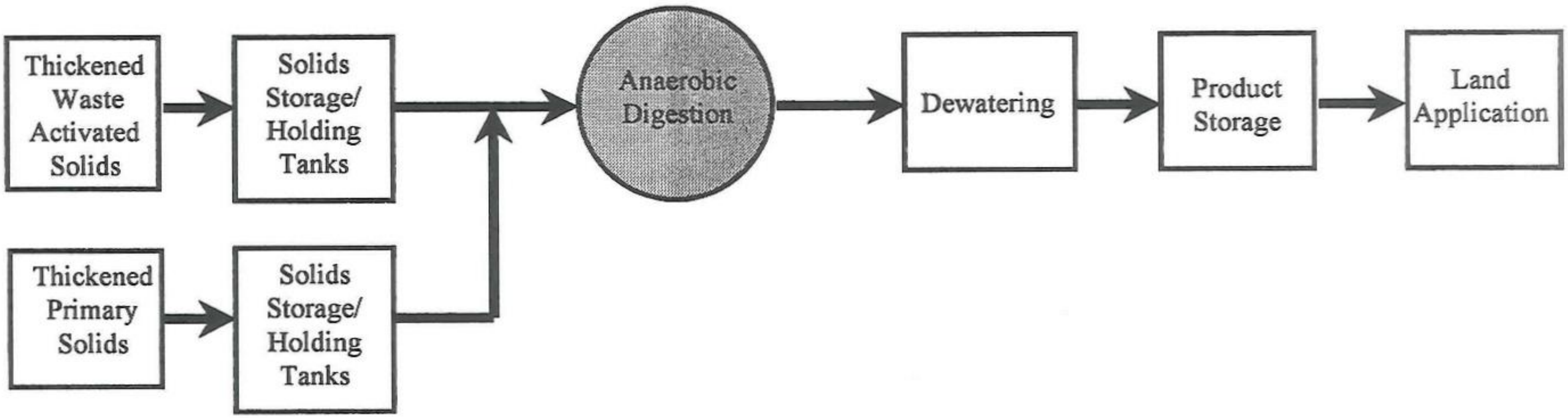
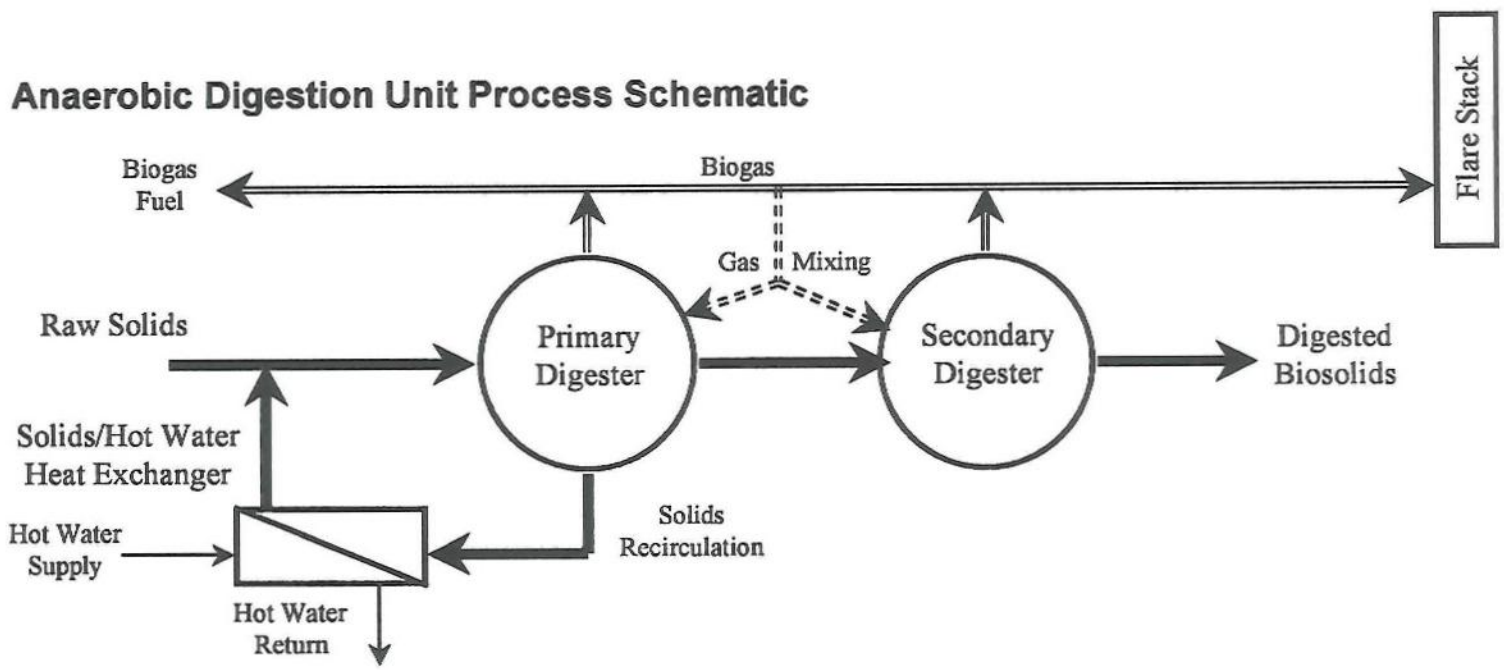
Figure 6-9
Anaerobic Digestion (Alternative 5)

Solids Processing Block Diagram



Anaerobic Digestion Unit Process Schematic



To efficiently store and seasonally transport the digested biosolids to agricultural lands, the dilute digested biosolids are conditioned with polymer and dewatered with high solids centrifuges. The dewatering process increases the biosolids concentration to approximately 26 percent. Dewatered biosolids are stored in a cake storage facility until cropping cycles and climatic conditions allow the application of biosolids to agricultural lands. Agricultural land owners accept biosolids on their lands but generally will not pay for these services.

The methane gas produced in the digestion process is used to heat the solids flow entering the digesters, as necessary, to maintain the operating temperatures near 95° F. Excess methane gas is used to augment the plant heating requirements.

The digestion system consists of six 120-foot diameter anaerobic digesters with a sidewall height of approximately 70 feet, sized to provide a 20-day HRT with one unit out of service for cleaning. Digested biosolids are dewatered with 7 centrifuges. Dewatered digested biosolids are stored in 14 covered cells, 75 feet wide and 265 feet long, for up to 180 days.

Facility Location and Layout

As shown on Figure 6-10, the Alternative 5 anaerobic digestion and cake storage facilities would be located at the northeast corner of the Metro Plant site, east of the East Primary tanks. The digestion facilities and storage facilities occupy approximately 365,000 square feet of the plant site. Liquid solids piping and utilities are routed to the digesters by tunnels. The digestion complex connects to the existing plant via the primary tank tunnel that provides space for solids piping and utilities.

Alternative Configuration

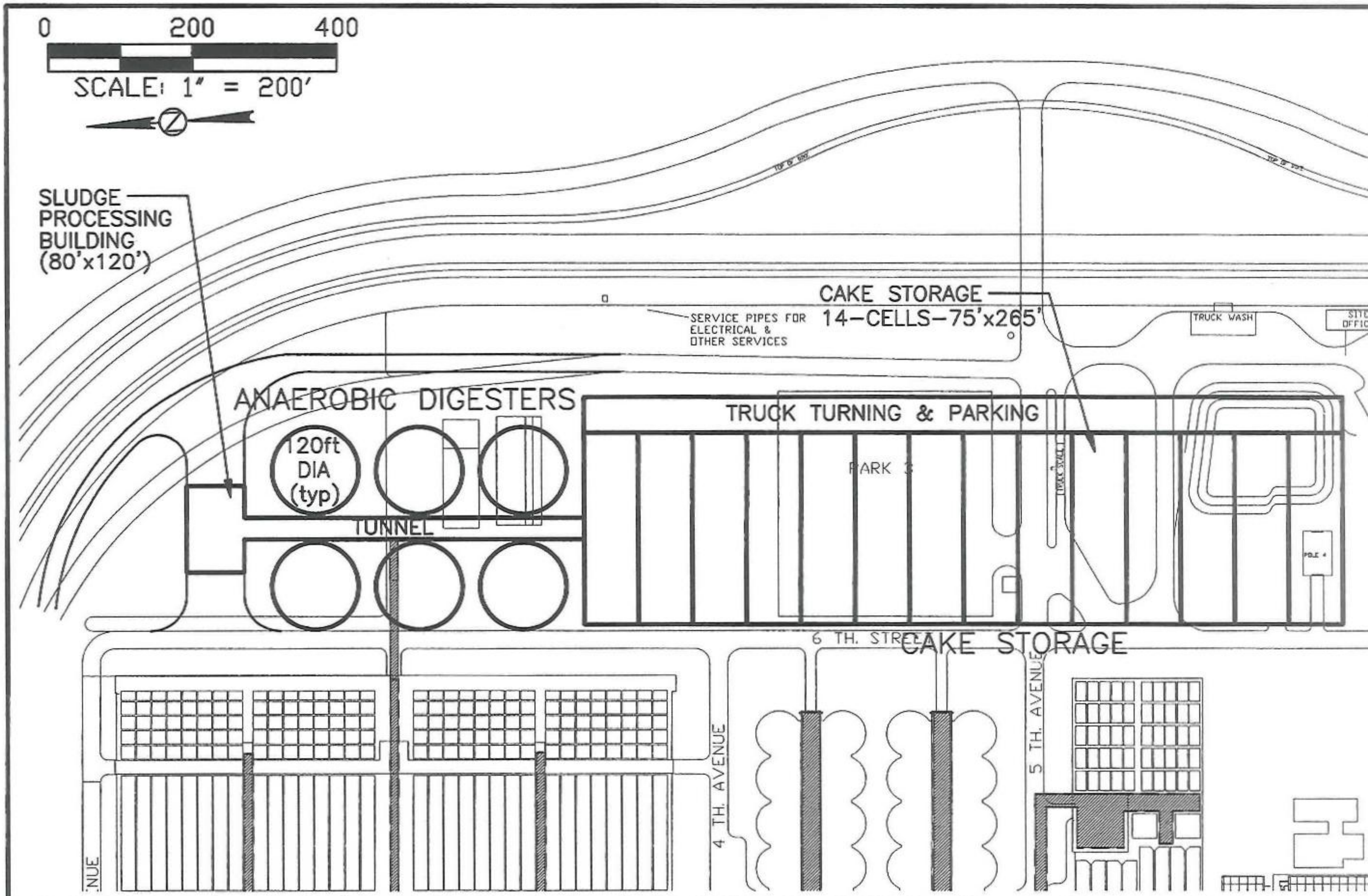
An alternative configuration was identified in which the dilute digested biosolids stream would be thickened in solid bowl centrifuge thickening units to produce a product with a dry solids concentration in a range of 9 to 10 percent. The thickened product, still a liquid, is pumped into either storage tanks or transport trucks for delivery to the agricultural application site. At the application site, the digested biosolids are transferred into application vehicles that are designed to inject the digested biosolids 6 to 8 inches below the ground surface.

A key advantage of this alternative approach is the reduced potential for release of objectionable odors at the Metro Plant and at the agricultural application site. The odor potential is reduced because the biosolids are contained in a closed vessel until they are injected into the soil.

Disadvantages of this approach include higher costs for storage of more dilute biosolids, higher transportation cost for hauling more dilute biosolids to the application site, more truck traffic, and no ability to apply the digested biosolids to agricultural land in the winter months. For these reasons, this alternative was eliminated from additional evaluation.

Alternative 6: Alkaline Stabilization

Alternative 6, alkaline stabilization, consists of dewatering wastewater solids, adding an alkaline material in nearly equal weight to the dry weight of the wastewater solids to raise the pH above 12, and passing the mixture through a rotary drum dryer to remove ammonia and moisture. The partially dried alkaline



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ANAEROBIC DIGESTION WITH CAKE STORAGE (ALTERNATIVE 5)

Figure 6-10

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Xrefs: CDSITE1, 11TITBLK, JNK-FIG1

product, a Class A biosolids product, would be stored in an enclosed building with a storage capacity for 180 days of production. Figure 6-11 provides a process flow diagram for the alkaline stabilization alternative that will produce a Class A biosolids product. The dewatering system consists of eight centrifuges, each capable of treating 220 gpm of solids. Based on the annual average solids production in 2005, between four and five centrifuges will operate continuously, with seven required to handle the 2040 peak week loadings. The alkaline system consists of four alkaline/solids mixers, four rotary drum dryers, and product storage facilities. Dewatered solids loadout and load-in facilities are included for emergency conditions when more than one alkaline processing train is removed from service.

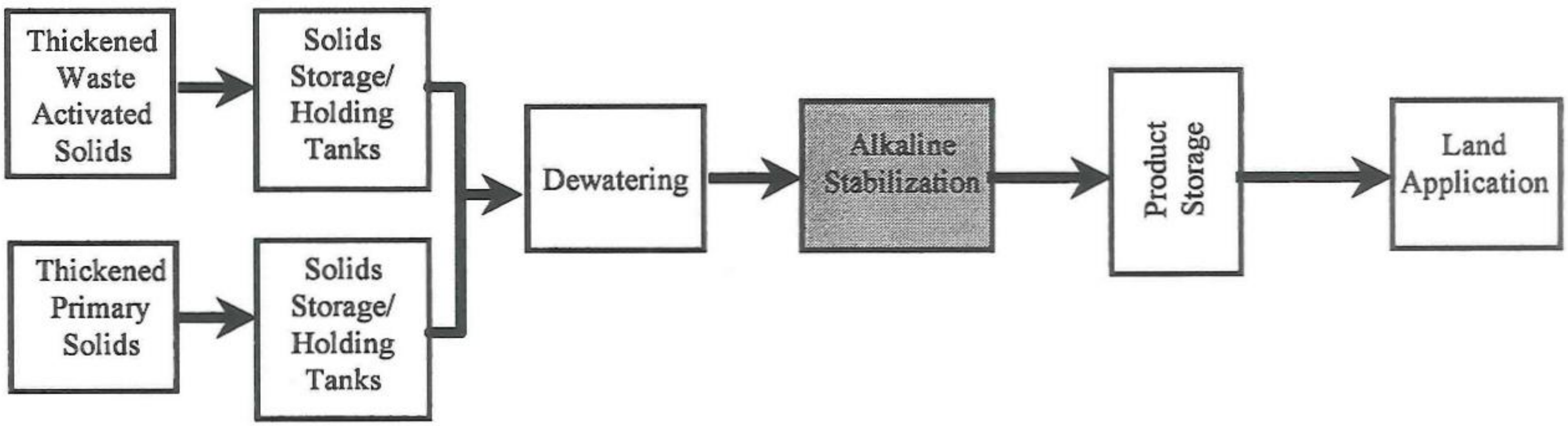
Each processing train for the production of an alkaline stabilized biosolids product consists of a mixer, rotary drum dryer, cyclones, and packed tower scrubbers. The mixer combines the wastewater solids with the alkaline admixture and conveys the mixture to the rotary dryer. Each dryer is a single pass co-current flow dryer (material and hot gases flow in the same direction) with drum dimensions of 50 feet long and 10.5 feet in diameter. Drying air for each dryer is provided by a combustion chamber 21 feet long and 5 feet in diameter. Exhaust air flow from each dryer is 19,500 acfm. Air pollution control equipment is provided to control emissions from the dryer.

Material entering the dryer has a dry solids concentration of 44 percent (56 percent water). The dryer raises the temperature of the product to sufficiently kill pathogenic organisms and to partially dry the solids to 65 percent dry solids concentration. In addition, ammonia is released in the dryer, which significantly reduces objectionable odors associated with the product. Ammonia in the waste air stream is removed in the acid scrubber. This dryer is an indirect rotary drum dryer as opposed to the direct dryers previously described in Alternatives 3 and 4. This dryer does not produce a pelletized biosolids product. It is required for this alternative to reduce the volume of alkaline stabilized product in order to minimize storage requirements, and to control ammonia odors.

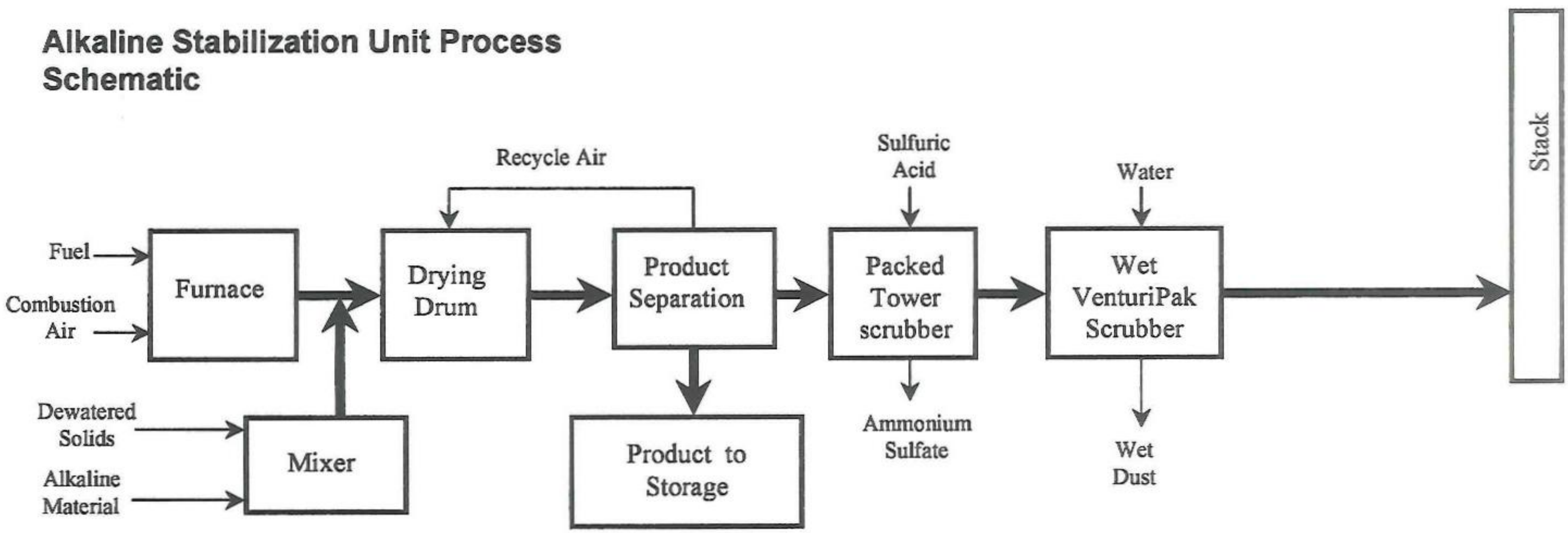
Alkaline product discharged from the dryer is conveyed to an enclosed product storage facility providing approximately 180 days of storage capacity. To reduce the operating ventilation and odor scrubbing requirements, the storage facility is divided into 17 storage cells 265 feet long by 75 feet wide. Material is stockpiled in each cell by a front-end loader to an average height of 16 feet. The cells are isolated to allow different levels of ventilation for active storage and standby operating conditions. An active operating condition is when workers and equipment would be in a storage cell during the filling or emptying of a cell.

Figure 6-11
Alkaline Stabilization (Alternative 6)

Solids Processing Block Diagram



Alkaline Stabilization Unit Process Schematic



A storage operating condition is when a cell contains some alkaline product in a storage mode without the addition or removal of material from the cell. Standby status is when a cell is empty and clean. Air exchange rates and total air flows from a cell for the three operating conditions are the following:

Required Air Flows

Operating Condition	Air Changes Per Hour	Total Air Flow Per Cell
Active	6	49,700 cfm
Storage	1	8,300 cfm
Standby	0	0 cfm

The total air flow with three active cells and all remaining 14 cells in a storage condition is approximately 300,000 cfm and requires 12 25,000-cfm odor control trains. Odor control scrubbers are located in the odor control building to prevent freezing in the scrubbers during cold winter conditions. In addition to the odor scrubbers, chemical storage tanks and chemical feed pumps to support the odor control process will be housed in the odor control building. Odor scrubbing systems will mitigate the potential for odorous air impacting residents adjacent to the Metro Plant. Operators working within an active cell may be required to wear respirators as a safety precaution.

Loadout of stored biosolids product will be partly controlled by climatic conditions and the agricultural cropping cycles. Land application on frozen ground may be prohibited in the future and it is currently prohibited in some states. In addition, farmers will not accept the material when some crops are in the growth or harvest phases. Thus, the window for removing material from storage may be limited and will influence the trucking of material. For example, based on projected solids quantities in year 2005 and assuming the storage facility is full, it would require 124 20-ton truck loads per day, hauling material 6 days per week, to empty the storage facility in a 3-month period.

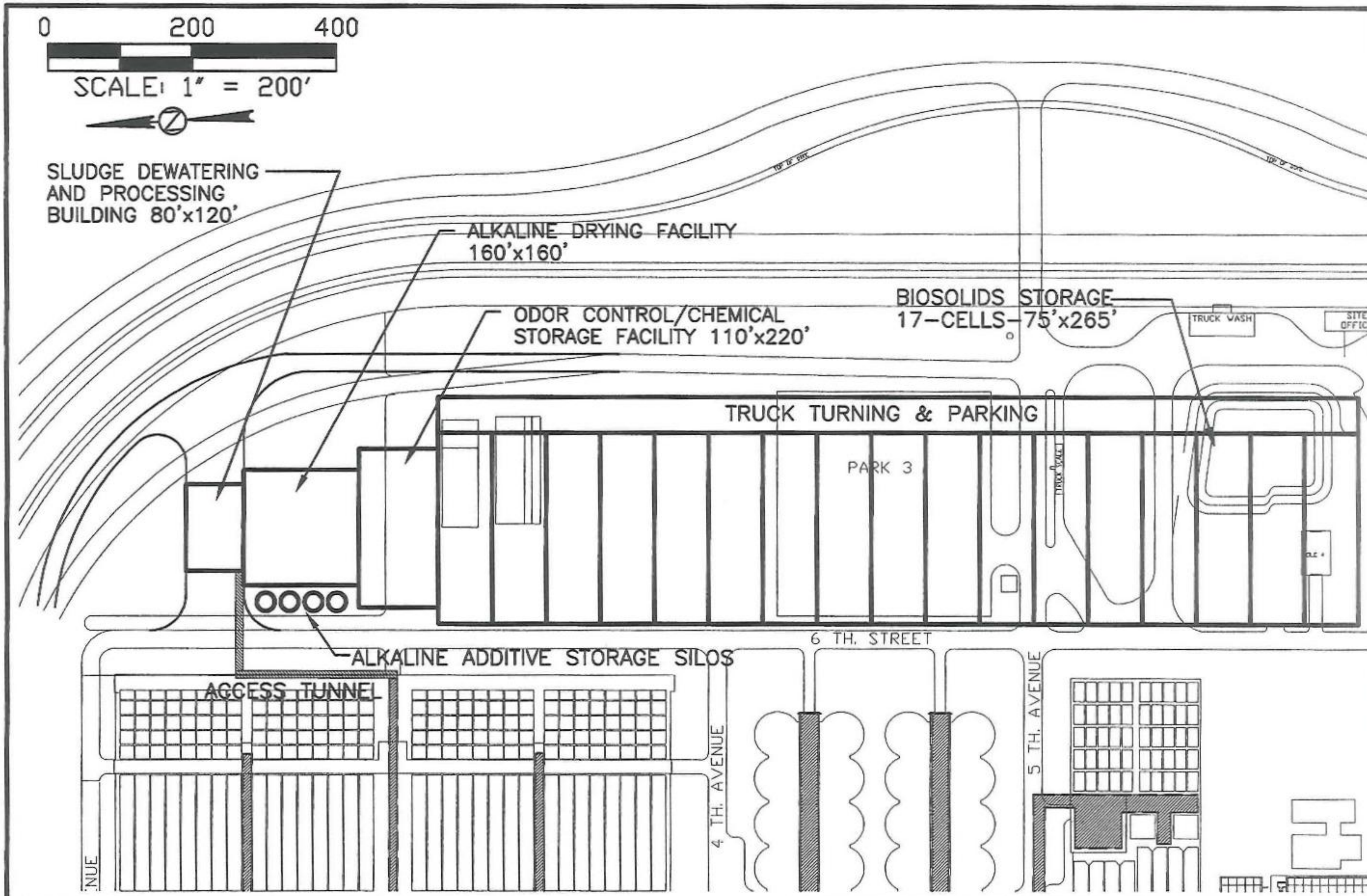
Facility Location and Layout

As shown on Figure 6-12, the alkaline stabilization facility would be located at the northeastern corner of the Metro Plant site, adjacent to the East Primary tanks. The buildings occupy less than 400,000 square feet of the plant site.

New facilities connect to the existing plant via the primary tank tunnel that provides space for solids piping and utilities.

Rehabilitation of Existing Multiple Hearth Incinerators

This option was evaluated to determine if there was any way to meet future air requirements cost effectively with the existing equipment. Based on MCES's experience at the Seneca WWTP, where an existing multiple hearth incinerator was rehabilitated, preliminary costs were developed for upgrading the six larger units at the Metro Plant. The air pollution control train was upgraded to meet future air emission requirements in addition to improved mercury removal. The capital costs of this alternative, which included the rehabilitation of all six multiple hearth incinerators, six wet electrostatic precipitators, six RHOX units for complete combustion of all organics, and the building addition to house the



Metropolitan Council
Environmental Services

ALKALINE STABILIZATION WITH 6MO. STORAGE
& ODOR CONTROL (ALTERNATIVE 6)

Figure 6-12

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Drawing File: ENV\MCES\METROSOL\12353_01\FACPLANFIGURES\FIG6-12.DWG.DWG (Elfstrom)
Xrefs: CDSITE1, 11TBLK, JNK-FIG1

new air pollution control equipment, was equal to the capital cost of the other alternatives. However, there was no technology identified or cost included to correct the emergency stack intermittent discharge that occurs whenever the incinerator pressure goes positive or any other system component fails. This is a current issue with regulatory agencies and is a difficult and costly item to correct. This alternative was concluded to be non-viable as there are: a) no capital cost savings; b) higher cost to operate the less efficient combustion facilities and to operate and maintain more trains of equipment; and c) permitting risks with the emergency stacks. Additional information on this alternative is included in Appendix C.

Evaluation of Technologies to Produce Biosolids for Agriculture

An additional evaluation of technologies to produce biosolids for agriculture was initiated to further examine all stabilization alternatives that are capable of supplementing FBIs and producing a biosolids product suitable for land application. This evaluation was initiated after the Council included a supplemental land application stabilization alternative with the recommended technology selection of three FBIs. All stabilization alternatives that are capable of supplementing FBIs and producing a biosolids product suitable for land application were studied as described below.

The biosolids production system must include full odor control provisions, be cost effective, and have capacity to adequately supplement FBIs to accommodate peak loads during periods when all units are in service or when one unit is removed from service. It is anticipated that biosolids system will treat approximately 10 percent of the solids collected at the Metro Plant.

Biosolids Facility Selection Criteria

Requirements of a supplemental biosolids facility include the following:

1. Ability to be reliably operated on an intermittent basis
2. Ability to be immediately (within a 24-hour period) placed into operation
3. Ability to treat a wide range of biosolids quantities
4. Having low mechanical complexity and maintenance requirements
5. Having no objectionable odor impacts on residents near the Metro Plant
6. Having low capital cost and lowest life-cycle costs
7. Ability to comply with air emission requirements
8. Ability to produce a Class A or Class B product

These requirements were used as criteria to evaluate various biosolids technologies.

Operation and Maintenance Considerations

It is likely that the land application biosolids process (biosolids facility) will be operated intermittently, at MCES's discretion. In the foreseeable future, three FBIs would have capacity to process the average projected quantities of solids produced at the Metro Plant. However, during peak solids productions periods and/or when one of the FBIs is removed from service, the biosolids facility will be required to successfully process and stabilize part of the Metro Plant's solids. The biosolids facility may be operated at any time.

Critical operational periods for the biosolids facility will occur when a unit, including downstream air pollution control equipment, is quickly removed from service for unscheduled maintenance. At that time, the supplemental biosolids facility needs to be fully operational within 24 hours. The plant has 6 million gallons of solids storage capacity for thickened primary and waste activated solids, which provides approximately 3.5 days of total storage. During normal operations, 1 day of storage volume will be used to equalize the feed solids to the dewatering process. With 1 day needed for start-up of the biosolids processing system, less than 2 days of storage capacity remain for other emergency conditions.

The equipment must be easily started and shutdown due to the potential to frequently start and stop the biosolids facility.

In addition, the biosolids process equipment should have the flexibility to be easily operated over a wide range of loadings. For example, if the peak loadings are only slightly above the capacity of the operating trains, the loading could be as low as 20 to 30 dtpd. On the other hand, the peak loadings in 2040 could be as high as 194 dtpd. Thus, a wide range of operating system capacity is required.

Odor Impacts

Public interest in the project has emphasized the need to reduce odors from the Metro Plant. The public interest in having a biosolids product for agricultural application cannot be at the sacrifice of increased odor impacts on residents near the Metro Plant.

Cost Considerations

Capital costs should be low since the biosolids facility may be operated intermittently with a very nominal annual production. Although operational cost must be considered, total annual operating cost will not be significantly impacted due to low annual quantity of biosolids produced. The selected process alternative should be among the lowest life-cycle costs of the alternatives.

The processing equipment should not require high maintenance, as it will have infrequent use. In addition, the biosolids mechanical train needs to have a minimum of complexity so operational staff without special training can easily operate it every time the process is placed in service.

Air Emission

All processes need to be designed to comply with air permit requirements. Intermittent operations create the potential for complex air scrubbing equipment to be fully operational at all times. It is highly speculative to expect this to occur. Therefore, those processes requiring complex air pollution control technology will most likely not meet the air permit requirements.

Impacts of Class A or Class B Product

Agricultural use of biosolids is primarily for nitrogen, organics, and some alkaline material to control soil acidity. Nitrogen is the most valuable benefit of biosolids application to most agricultural soils.

The regulatory classification of a biosolids product will impact the administrative requirements for land application of biosolids. For example, the

Federal EPA Part 503 Regulations define treatment options to ensure that pathogen levels in biosolids are reduced to levels considered safe for the product to be land applied. Subpart D of the regulations includes criteria to classify biosolids as Class A or Class B with respect to pathogens. These classifications are based on the level of pathogens present in the biosolids to be land applied. If pathogens are below detectable levels, the biosolids meet the Class A designation. Biosolids are designated Class B if pathogens are detectable, but have been reduced to levels that do not pose a threat to public health and the environment when appropriate barriers to exposure are in-place. In agricultural application of a Class B biosolids product, site restriction barriers include the following:

- Animals shall not graze on the land for 30 days after application of biosolids.
- Food crops with harvested parts that do not touch the biosolids/soil mixture, feed crops, and fiber crops shall not be harvested for 30 days after application of biosolids.
- Food crops with harvested parts that touch the biosolids/soil mixture and are totally above the land surface shall not be harvested for 14 months after application of biosolids. The time restriction is increased up to 38 months if the food crops are harvested from below the ground surface and the biosolids were incorporated into the soil within 4 months of application.

Therefore, in the evaluation of alternatives, impacts of Class A and Class B products must be considered. Technology alternatives to produce biosolids for agricultural application include the following:

- Anaerobic Digestion producing a Class A or B Product
- Heat Drying producing a Class A Product
- Alkaline Stabilization producing a Class B Product
- Alkaline Stabilization producing a Class A Product
- Composting producing a Class A Product

Evaluation of Biosolids Production Alternatives

Each of the identified treatment technologies for the production of a biosolids product are designated by product type and evaluated for compliance with the other selection criteria in the following tables:

Anaerobic Digestion Producing a Class A or B Product

	Selection Criteria	Compliance
1.	Ability to be reliably operated on an intermittent basis	No
2.	Ability to be immediately (within a 24-hour period) placed into production	No
3.	Ability to treat a wide range of biosolids quantities	No
4.	Having low mechanical complexity and maintenance requirements	Yes
5.	Having no objectionable odor impacts on residents near the Metro Plant	No
6.	Having low capital cost and non-excessive operational costs	No
7.	Ability to comply with air emission requirements	Yes

Anaerobic digestion producing a Class A or B product is concluded to be a non-viable alternative as the biological digestion process is not amenable to instant startup. In addition, the capital costs for tankage to hold 15 days of solids production at a peak design capacity of 192 dtpd would be excessive.

Heat Drying Producing a Class A Product

	Selection Criteria	Compliance
1.	Ability to be reliably operated on an intermittent basis	Yes
2.	Ability to be immediately (within a 24 hour period) placed into production	Yes
3.	Ability to treat a wide range of biosolids quantities	No
4.	Having low mechanical complexity and maintenance requirements	No
5.	Having no objectionable odor impacts on residents near the Metro Plant	Yes
6.	Having low capital cost and non-excessive operational costs	No
7.	Ability to comply with air emission requirements	Questionable

Heat drying producing a Class A product is concluded to be a non-viable alternative because the process would require high capital cost. Also, the complex air emission control equipment may not consistently meet permit requirements when operated intermittently.

Alkaline Stabilization Producing a Class B Product

	Selection Criteria	Compliance
1.	Ability to be reliably operated on an intermittent basis	Yes
2.	Ability to be immediately (within a 24-hour period) placed into production	Yes
3.	Ability to treat a wide range of biosolids quantities	Yes
4.	Having low mechanical complexity and maintenance requirements	Yes
5.	Having no objectionable odor impacts on residents near the Metro Plant	Yes
6.	Having low capital cost and non-excessive operational costs	Yes
7.	Ability to comply with air emission requirements	Yes

Alkaline stabilization producing a Class B product is concluded to be a viable alternative. Simplicity of operation, relatively low capital cost, and the ability to be immediately placed into or taken out of operation are the key considerations making this a viable process.

Alkaline Stabilization Producing a Class A Product

	Selection Criteria	Compliance
1.	Ability to be reliably operated on an intermittent basis	Yes
2.	Ability to be immediately (within a 24-hour period) placed into production	Yes
3.	Ability to treat a wide range of biosolids quantities	Yes
4.	Having low mechanical complexity and maintenance requirements	Yes
5.	Having no objectionable odor impacts on residents near the Metro Plant	Yes
6.	Having low capital cost and non-excessive operational costs	No
7.	Ability to comply with air emission requirements	Yes

Alkaline stabilization producing a Class A product is concluded to be a viable alternative. Simplicity of operation, relatively moderate capital cost, and the ability to be immediately placed into or taken out of operation are the key considerations making this a viable process. The slightly higher capital cost for a Class A product provides space for truck trailers to be stored for monitoring product temperature and pH, as required to achieve the Class A product classification.

Composting Producing a Class A Product

	Selection Criteria	Compliance
1.	Ability to be reliably operated on an intermittent basis	No
2.	Ability to be immediately (within a 24-hour period) placed into production	No
3.	Ability to treat a wide range of biosolids quantities	Yes
4.	Having low mechanical complexity and maintenance requirements	Yes
5.	Having no objectionable odor impacts on residents near the Metro Plant	No
6.	Having low capital cost and non-excessive operational costs	No
7.	Ability to comply with air emission requirements	Yes

Composting producing a Class A product is concluded to be a non-viable alternative as the process requires either expensive equipment for in-vessel composting or a large building for windrow or static pile composting. In addition, the composting process would be difficult to startup and operate in the winter during sub-zero temperatures.

Preferred Technology for a Supplemental Biosolids Facility

Alkaline stabilization is the most viable process to be operated on an intermittent basis, with a wide range of solids processing capacity at the lowest life-cycle costs. The differences between the production of a Class A and B product are the handling requirements following the addition of the alkaline material to the dewatered solids cake. For a Class A alkaline biosolids product, the product blend is held in a container to verify that the product is maintained at a temperature of 52° C for a minimum of 12 hours while the pH is greater than 12 without further addition of alkaline material for a minimum of 72 hours.

The requirements for a Class B product include maintaining the product at a pH of greater than 12 with a temperature of greater than 25° C for 2 hours, with the pH staying above 11.5 for an additional 22 hours. These requirements for a Class B product are less difficult to meet and can be monitored in a storage facility.

For either biosolids classification, it is desirable to have a dry solids concentration above 50 percent. A 50 percent dry solids concentration aids in achieving the desired pH range and improves the material handling characteristics of the product. Coal ash, in addition to the alkaline material, will be blended with the dewatered solids to achieve this dry solids objective.

Historically, MCES has used truck trailers to hold the alkaline mixture for the above prescribed time periods to ensure production of a Class A biosolids product. Therefore, the primary differences in capital facilities to produce Class A and B products are the storage requirements (i.e., truck trailers) for monitoring pH and temperature. The primary differences in operating costs for Class A and B products are associated with environmental restrictions and reporting requirements. Class B products will require individual site permits as well as extensive record keeping and report preparation to comply with crop harvesting and public access restrictions. Given the intermittent production of biosolids product, these on-going operating costs defeat the small capital advantage of producing a Class B product. Therefore, it is recommended that flexibility be incorporated into the project to enable the production of a Class A alkaline biosolids product for a portion of the production (up to 40 dtpd). When alkaline stabilization production requirements exceed this capacity, the excess will be processed into a Class B product and stored separately prior to land application. To provide this flexibility, it is recommended that a truck trailer storage facility be provided including provisions for odor control of the storage area and facilities for loading and unloading trucks.

Air Emissions

The following sections include a discussion of the air pollutants of concern from each alternative technology and a discussion of associated air pollution control technologies. The air pollution control system is representative of the level of control that will be needed. Individual components may change as design details are developed.

Fluid Bed Incineration

The FBI alternatives consist of incinerating centrifuge dewatered solids cake in a FBI system. The organics in the solids are oxidized to carbon dioxide (CO_2) and water and are exhausted with the off-gases. The inert fraction of the solids is exhausted as ash with the off-gases. The FBI system is equipped with air pollution control equipment to clean the off-gases, prior to discharge to the atmosphere.

Types of Pollutants of Concern

The emissions from FBIs include both organic and inorganic compounds, generally consisting of inorganic gases (CO, NO_x, SO_x, HCl) particulate matter, heavy metals, and hydrocarbons (organic compounds). The fluidized bed and freeboard sections act as an afterburner because of the uniform temperature in the bed and freeboard zones and the long residence time in the freeboard (5 to 7 seconds at temperatures about 1,550°F). No single control technology is capable of controlling all of these pollutants. Brief descriptions of the pollutants of concern are provided below.

CO. High CO levels are indicative of incomplete combustion. CO generation increases as air supply and combustion temperatures decrease. Formation of CO is controlled by maintaining adequate levels of excess air within the incinerators. CO generation is much lower in FBIs than in other types of incinerators because of uniform, high combustion temperatures, good mixing of air and combustibles, and longer residence time inside the incinerator and freeboard sections

NO_x. Nitrogen oxides are generated primarily by the supplemental fuel burners and also by oxidation of organic nitrogen present in the solids itself. There are two NO_x formation mechanisms.

The first is known as thermal NO_x and is formed at temperatures of 1,800°F and above. Nitrogen in the air is oxidized to NO_x. This reaction depends on the temperature and oxygen available for reaction. The higher the temperature, the more rapid the formation and the higher the concentrations formed. Thermal NO_x is readily formed in burner flames and in flames formed by burning solids particles.

The second NO_x forming mechanism is known as fuel NO_x. Nitrogen in the fuel is converted to NO_x. In solids combustion, only a portion of the nitrogen is converted to NO_x. Fuel NO_x formation is a function of the type of solids, the moisture content, the temperature, and the available oxygen. Solids with a high proportion of waste activated solids produce lower NO_x than those with a high proportion of primary solids. FBIs produce lower NO_x emissions than other types of solids incinerators, mainly because of characteristics of the fluidized bed.

Upon entering the bed, solids cake is broken into particles by turbulence in the bed. Heat from the sand particles raises the temperature of the solids particles to evaporate moisture and begin combustion. The oxygen in the fluidizing air combines with the combustible components in the solids particles to sustain combustion. Heat produced by this combustion is transferred to the excess air, evaporated moisture, and sand particles. Because the sand in the bed provides a large heat sink and evaporated moisture removes heat quickly, temperatures around the burning solids particles remain uniform and relatively low (1,450 to 1,500°F), which leads to low fuel NO_x formation rates.

Formation of nitrogen oxides by the burners can be minimized by appropriate burner selection (low NO_x burners) and controlling incinerator temperatures. Where autogenous combustion takes place, NO_x formation from the burners is not a consideration.

SO_2. Sulfur oxides are formed by the oxidation of sulfur-containing compounds in the sewage solids. Sulfur oxides are readily soluble in water, forming sulfuric acid, and are a major contributor to acid rain. Sulfur oxides are a function of the fuel and materials burned and should be consistent between the various incinerator types.

HCI. When chlorine-containing compounds are burned, the chlorine combines with hydrogen from water to form hydrogen chloride. Hydrogen chloride is readily soluble in water and forms hydrochloric acid.

Particulates. Particulate matter results primarily from carry-over of fine ash particles by the moving air stream. The amount of ash discharged into the exhaust gas is a function of the turbulence the solids experience in the burning process. Some of the sand becomes fine enough over time, due to erosion, to be carried over with the exhaust gas. Most of the fine particles in an FBI must be controlled in the abatement train, whereas only 5 to 30 percent of the fine particles must be controlled in a multiple hearth incinerator abatement train.

Heavy Metals. Heavy metals generally concentrate in sewage solids. The heavy metals of greatest concern in the fluid bed incineration process are arsenic, beryllium, cadmium, chromium, lead, mercury, and nickel. Metals present in the incinerator feed oxidize, and either stay with the ash or exit in the exhaust as particulate matter or as free metal oxides. As the vaporised metals cool, they condense into larger particulate matter or adsorb to ash particulates and can be removed as particulates. The exception to this is mercury. Mercury only partially oxidizes due to its high volatility. The elemental portion does not condense or adsorb to particulate at temperatures normally encountered in air pollution control trains and thus is difficult to remove from the exhaust gas stream.

Organics. Volatile organic pollutants are produced by vaporization and incomplete combustion of volatile materials. Volatile organics can be visible, generate smoke, and cause odors. Polycyclic organic matter, including PCBs, dioxins, and furans, are suspected carcinogens. Generation of volatile organic pollutants is much lower in FBIs than in the other types of incinerators because the fluidized bed maintains uniform, high combustion temperatures, and longer residence time inside the incinerator and freeboard sections.

CO_2. Carbon dioxide, although not a regulated pollutant, is considered a greenhouse gas and a contributor to acid gas formation. CO_2 is formed by the oxidation or combustion of any chemical compound containing carbon. In solids combustion, CO_2 is formed from the oxidation of the solids and auxiliary fuel, if used. The major concern currently is with CO_2 produced from nonrenewable fuel resources, including natural gas and fuel oil. Wastewater solids are considered a renewable fuel source. There is no commercially available control for CO_2. However, reduced use of auxiliary fuel reduces the amount of nonrenewable fuel CO_2 produced.

Air Pollution Control Technology

The FBI process train selected for this alternative consists of a hot windbox FBI, a gas-to-air heat exchanger, a multiple cyclone if a dry electrostatic precipitator (ESP) is not used, a waste heat recovery boiler (WHB), a dry ESP, a wet venturi/impingement scrubber (VIS), and a wet ESP.

Particulates will be removed by the multiple cyclone, the WHB, the dry ESP, the VIS, and the WESP. The multiple cyclone and the WHB remove particulate matter 10 μm and larger. The ESP and the VIS remove particulates 1 μm and larger, and the wet ESP removes particulate matter less than 1 μm. Heavy metals, except for the volatile metals such as mercury, are removed as fine particulates.

Acid gases (HCl, SO_2) are removed in the VIS. Some NO_x is also removed in the VIS. Other pollutants produced during the incineration of solids are not removed by the air pollution control system. These include CO, THC, and dioxins/furans. The combustion process controls these pollutants.

Heat Drying

The heat drying alternatives consist of heat drying centrifuge dewatered solids cake in a direct heat dryer system. The solids cake is dried to about 95 percent dry solids. The resultant product consists of granules or pellets. The pellets are exhausted with the off-gases and are separated from the off-gases. The heat drying system is equipped with air pollution control equipment to clean the off-gases, prior to discharge to the atmosphere.

Types of Pollutants of Concern

The emissions from sewage solids heat dryers include both organic and inorganic compounds, generally consisting of inorganic gases from the burners (CO, NO_x, SO_x), particulate matter, heavy metals, and hydrocarbons (organic and odorous compounds) from the solids. No single control technology is capable of controlling all of these pollutants. Brief descriptions of the pollutants of concern are provided below. The next section discusses alternative control technologies that will be used to reduce these pollutants.

CO. High CO levels are indicative of incomplete combustion. Formation of CO is controlled by maintaining adequately tuned burners.

NO_x. Nitrogen oxides are generated primarily by supplemental fuel burners used for heating the drying air and for thermal oxidation of the exhaust gases. Formation of nitrogen oxides by the burners can be minimized by appropriate burner selection (low NO_x burners).

SO_2. Sulfur oxides are formed by the oxidation of sulfur-containing compounds in the fuel. Sulfur oxides are readily soluble in water, forming sulfuric acid, and are a major contributor to acid rain. Sulfur oxides are a function of the fuel.

Particulates. Particulate matter primarily results from the dried solids and the exhaust gas flow rates. The amount of particulate matter discharged into the exhaust gas is a function of the turbulence the solids experience in the drying process. Uncontrolled particulate emissions are due to the high air flow rates through the drier. Following separation of the dried solids from the exhaust gas, the exhaust gas is treated in the air pollution control system to remove particulates.

Heavy Metals. Heavy metals generally concentrate in sewage solids. Metals present in the dryer feed either stay with the dried solids or exit in the exhaust as particulate matter. The air pollution control equipment used for treating the particulate matter will provide the same level of reductions for particulates made up of the heavy metals. Since dryer temperatures are relatively low, most of the heavy metals will not vaporize into metal oxides. It is unlikely that treatment for heavy metals will be required.

Organics. Volatile organic pollutants are produced by vaporization in the drying process and incomplete combustion of fuel. Some minor combustion can occur in the dryer, depending on the operating scenario and the solids temperatures. Volatile organics can be visible, generating a smoke, and cause odors. Polycyclic organic matter, including PCBs, dioxins, and furans, typically are not emitted from dryers because of low drying temperatures.

CO_2. Carbon dioxide, although not a regulated pollutant, is considered a greenhouse gas and a contributor to acid gas formation. CO_2 is formed by the oxidation or combustion of any chemical compound containing carbon. In solids drying, CO_2 is formed from the oxidation of the auxiliary fuel. The major concern currently is with CO_2 produced from nonrenewable fuel resources, including natural gas and fuel oil. There is no commercially available control for CO_2. However, reduction in the use of auxiliary fuel reduces the amount of nonrenewable fuel CO_2 produced.

Air Pollution Control Technologies

The heat drying process train selected for this alternative consists of a direct rotary drum dryer with a furnace, a wet VenturiPak (VP), and a regenerative thermal oxidizer (RTO).

Particulate removal will be done by the VP. The VP removes particulates 1 μm and larger and particulate matter less than 1 μm. Heavy metals are removed as fine particulates. Acid gases (SO_2), if any, are removed in the VP. Some NO_x is also removed in the VP, except from the RTO, which is located downstream of the VP. Organic compounds and odors are oxidized by the RTO.

Anaerobic Digestion

The gravity thickened primary solids and flotation thickened waste activated solids are fed to anaerobic digesters. Anaerobic digestion destroys 50 percent of the volatile organics in the solids and reduces the pathogen population to levels that will protect the environment when digested solids are land applied.

Types of Pollutants of Concern

CO_2. Carbon dioxide, although not a regulated pollutant, is considered a greenhouse gas and a contributor to acid gas formation. In anaerobic digestion, CO_2 is formed during digestion and makes up part of the digester gas, and is also formed during the combustion of methane in the digester gas. The major concern currently is with CO_2 produced from nonrenewable fuel resources, including natural gas and fuel oil. Digester gas is considered a renewable fuel source. There is no commercially available control for CO_2.

SO_2 Sulfur oxides are formed during the combustion of hydrogen sulfide contained in the digester gas. Sulfur oxides are readily soluble in water, forming sulfuric acid, and are a major contributor to acid rain.

Alkaline Stabilization

Alkaline stabilization consists of dewatering wastewater solids, adding an alkaline material in nearly equal weight to the dry weight of the wastewater solids to raise the pH to above 12 and passing the mixture through a rotary drum dryer to remove ammonia and moisture. The partially dried alkaline product, a Class A biosolids product, would be stored in an enclosed building with a storage capacity for 180 days of production.

Types of Pollutants of Concern

The emissions from the alkaline stabilization process generally consist of particulates and ammonia.

Particulates. Particulate matter primarily results from the alkaline stabilized solids. Particulate matter can be discharged through the exhaust gas in the drying process. Uncontrolled particulate emissions are due to the high air flow rates through the drier. Particulate matter can also be discharged from the enclosed alkaline product storage facility.

Ammonia. Ammonia is released from the wastewater solids when alkaline admixture is added, resulting in an increased pH. Although not regulated, ammonia can contribute to off-site odors.

Air Pollution Control Technologies

Particulate emission control will be accomplished using a cartridge air filtration system. A cartridge filtration system will be installed on both the dryer exhaust stream and the exhaust from the enclosed alkaline material storage facility.

Ammonia will be removed from both the dryer exhaust stream and the exhaust from the enclosed alkaline material storage facility using packed tower scrubbers.

Summary of Projected Air Emissions

Figure 6-13 provides a comparative summary of expected actual year 2005 air emissions for the stabilization alternatives of fluid bed incineration, heat drying, and heat drying/digestion. In general, the projected emissions are reduced considerably from existing multiple hearth incinerator emission projections.

Beneficial Reuse of Solids

Treatment of a metropolitan area's liquid waste, commonly known as sewage or wastewater, to protect the local surface and ground waters from pollution results in the production of wastewater solids. These solids contain a wide range of inorganic and organic compounds in various quantities, plus a large population of micro-organisms and viruses. Because of the wastewater treatment process employed, the residual solids are concentrated in various wastewater solids streams such as primary or waste activated solids with a range of solids concentrations from 0.8 to 6 percent dry solids.

Treatment of these wastewater solids streams, by the alternative technologies presented herein, produces residual solids. FBIs produce ash, drying produces a dried biosolids pellet, and anaerobic digestion produces liquid biosolids that could be land applied or dewatered, resulting in a biosolids cake material. Regardless of the solids treatment process employed, the residual is the waste of a wastewater treatment process – a byproduct that is not highly sought after.

Managing Ash from Solids Incineration

MCES is the only major wastewater agency that has been successful in the beneficial use of 100 percent of all annual ash quantities. A copy of the market study report, "Managing Ash from Biosolids Incineration", is provided in Appendix D. Development of local ash utilization markets in the concrete, mining, and roadway construction industries will provide additional market stability and reduce the costs from the current cost of $53 per ton.

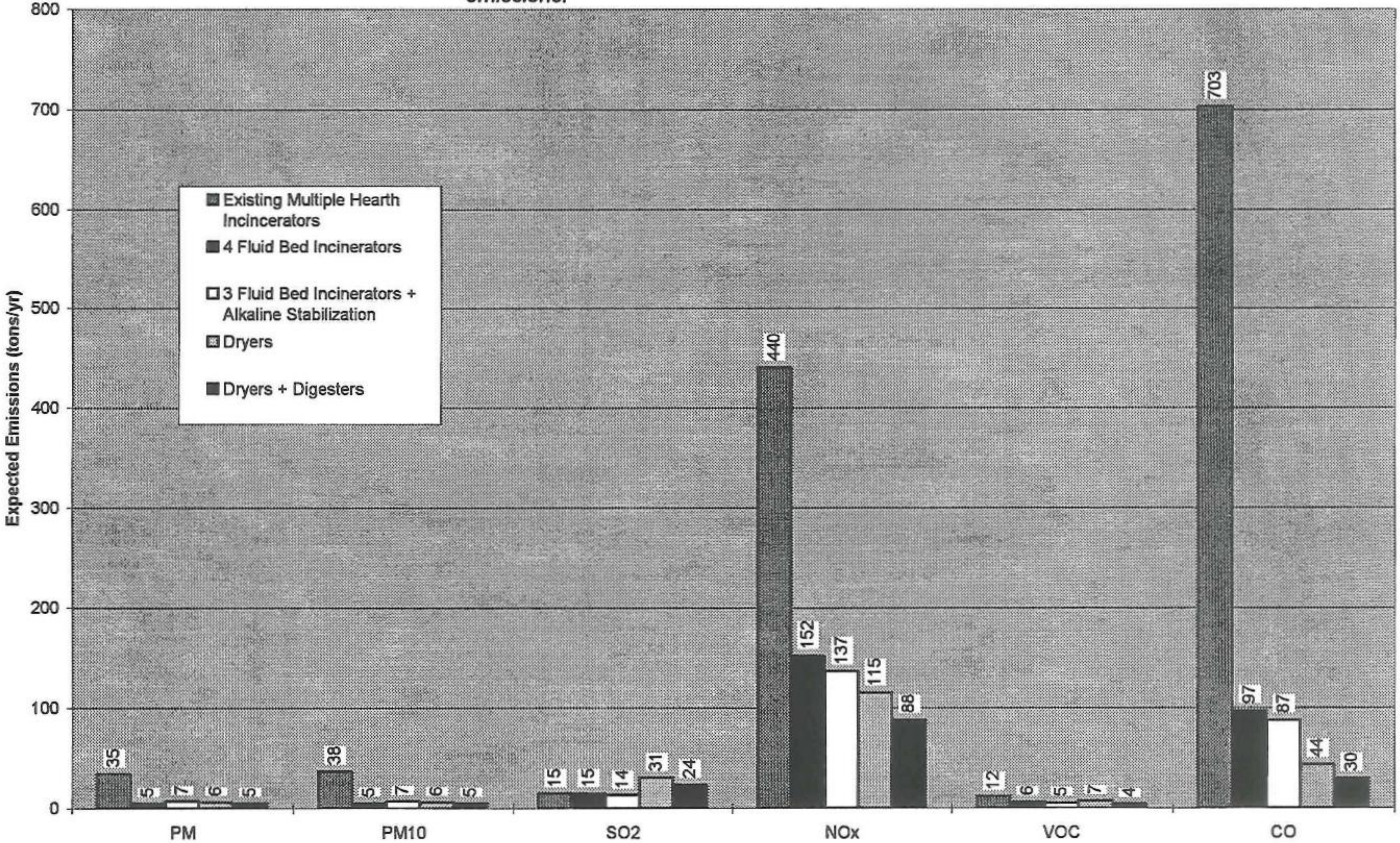
Marketing of a Dried Product

Vital Cycle, a company specializing in the marketing of dried biosolids, conducted a marketing study on the beneficial use of dried solids from the Metro Plant. The study concluded that current fertilizer needs within the local market are being met by commercially produced fertilizers with higher nitrogen content than is achievable with dried biosolids. Thus, a significant marketing effort would be required to enter the local agricultural market and displace existing products. This marketing effort has been successful in other areas, but could take up to 4 years to beneficially utilize a majority of the Metro Plant's dried

Figure 6-13

Expected Actual Emissions Comparison for the Year 2005

Any of the proposed options would result in a reduction of regulated air pollutant emissions.



biosolids. Market value is generally based on the nitrogen content of the dried biosolids, and transportation and marketing costs. At the end of the marketing study, it was estimated that the net potential revenue for a dried biosolids product is $5.00 per dry ton for the low nitrogen product and approximately $7.83 for a quality dried product. The latter is based on a percentage of the dried biosolids being blended with other products to provide a specialty fertilizer product. A copy of the report is included in Appendix E.

Management of Anaerobically Digested or Alkaline Stabilized Biosolids

Agricultural application of anaerobically digested or alkaline stabilized biosolids is a common beneficial reuse of wastewater biosolids. The agricultural industry will generally accept the biosolids without cost if the wastewater agency performs all related services, including:

- Frequently applying the biosolids
- Scheduling biosolids application at the most beneficial time for the crops
- Performing all monitoring and testing
- Complying with all regulatory requirements and submitting all reports

The cities of Rochester, Minnesota, and Madison, Wisconsin, anaerobically digest, store, and land apply all residual wastewater biosolids.

MCES has a significant amount of agricultural land permitted for biosolids application, and has applied digested solids to agricultural lands from Cottage Grove, Hastings, and Empire wastewater treatment facilities. MCES has also applied alkaline stabilized biosolids to agricultural lands from the Seneca WWTP. There are no foreseeable problems associated with acquiring sufficient agricultural land for supporting either anaerobic digestion or alkaline stabilization alternatives.

Non-monetary Evaluations

Non-monetary evaluations for the six solids stabilization alternatives are presented in Table 6-1.

Comparative Costs

The cost estimates for each alternative were developed to the same level of detail for comparison purposes. A more refined cost estimate for the recommended alternative is included in Section 3 – Recommended Alternative. In addition, future initial design studies on the recommended alternative will further refine the cost estimate for planning the implementation of the project. A detailed discussion of the cost analysis performed for the six alternatives presented herein can be found in Section 7 – Economic, Risk, and Financial Assessment.

Capital Costs

Capital cost estimates were based on equipment prices for the major equipment items such as FBIs and dryers; layouts of proposed facilities; current sizing criteria; allowances for undefined design features (25 percent); and engineering, legal, and administrative services (25 percent). Costs are in 1998 dollars. Section 7 and tables in Appendix E present the development of capital costs.

MWWTP Solids Processing Improvement Project
Table 6-1
Nonmonetary Evaluation

Evaluation Factors	Alternatives 1&2 Fluid Bed Incineration	Alternative 3 Heat Dried Low Nitrogen Product	Alternative 4 Heat Dried Quality Product	Alternative 5 Anaerobic Digestion	Alternative 6 Alkaline Stabilization
Staff Training	Familiar process, least number of processes (dewatering, incineration and air emission control), 4 processing trains, low attention to residuals, Full Time Equivalents Employees (FTE)-44	New process, small number of processes (dewatering, drying, air emissions and processing/storage of dried product), 6 process trains, attention to residuals due to market, storage, product quality, etc., FTE-54	New processes, significant number of unit processes (dewatering, drying, air emissions, dried product, anaerobic digestion, thickening and storage of digested sludge, digested sludge land application), FTE-60	New process, small number of unit processes (anaerobic digestion, dewatering and storage of digested sludge, digested sludge land application), FTE- 32	New process, small number of unit processes (thickening, dewatering, alkaline stabilization, alkaline stabilized sludge land application), FTE-44
Resource Requirements	Polymer lbs/yr=791,000 Natural Gas Therms/yr=365,000; Electricity Mkw-hrs/yr=33	Polymer lbs/yr=791,000 Natural Gas Therms/yr=6,426,380; Electricity Mkw-hrs/yr=41	Polymer lbs/yr=911,000 Natural Gas Therms/yr=1,140,000; Electricity Mkw-hrs/yr=33.5	Polymer lbs/yr=978,000 Natural Gas Therms/yr=30,000; Electricity Mkw-hrs/yr=25.7	Polymer lbs/yr=791,000 Natural Gas Therms/yr=420,000; Electricity Mkw-hrs/yr=25.8
Space Impacts and Visual Impacts	125,000 sf, space available for future facilities, some visual impact of new structures	95,000 sf, space available for future facilities, some visual impact of new structures	350,000 sf, reduced space available for future facilities, major visual impact of new facilities (tank farm appearance)	365,000 sf, reduced space available for future facilities, major visual impact of new facilities (tank farm and storage cells)	400,000 sf, space available for future facilities, some visual impact of new structures
Air Emissions	Significantly reduced air emissions from existing conditions	Significantly reduced air emissions from existing conditions.	Significantly reduced air emissions from existing conditions.	Significantly reduced air emissions from existing conditions.	Significantly reduced air emissions from existing conditions.
Odors	Very little, dewatering and conveyance to incinerators are primary sources	Very little, dewatering and conveyance to drying are slight; dried product will exhibit some odor due to high percentage of primary solids	Very little, dewatering and conveyance to drying are slight; anaerobic digestion and storage will have odor potential that must be controlled	Some, anaerobic digestion and storage will have odor potential that must be controlled.	Some, dewatering and conveyance to alkaline stabilization are slight; stabilization process and product storage will have significant odor potential that must be controlled

MWWTP Solids Processing Improvement Project
Table 6-1
Nonmonetary Evaluation

Evaluation Factors	Alternatives 1&2 Fluid Bed Incineration	Alternative 3 Heat Dried Low Nitrogen Product	Alternative 4 Heat Dried Quality Product	Alternative 5 Anaerobic Digestion	Alternative 6 Alkaline Stabilization
Water Quality Impacts	Slight, residual ash used as concrete additive	Slight, mis-application and surface runoff reaches a water course	Slight, mis-application and surface runoff reaches a water course	Slight, mis-application and surface runoff reaches a water course	Slight, mis-application and surface runoff reaches a water course
Beneficial Reuse of Residuals	Ash used as a low value additive in the concrete/asphalt industry at a cost to MCES.	Dried biosolids used in agriculture as a low nitrogen soil conditioner with potential for dust and odors.	Digested biosolids injected in agricultural soils and dried biosolids spread on agricultural soils or blended with other materials for landscape and golf course applications	Digested biosolids applied to agricultural soils	Alkaline stabilized biosolids used in agriculture as a pH conditioner.
Residual Quantities at year 2005	Ash = 63 dt/d	Low nitrogen dried product = 252 t/d	Quality dried product = 144 t/d, Anaerobically digested biosolids = 64 dt/d	Anaerobically digested biosolids = 149 dt/d	Alkaline product = 466 dt/d
Flexibility	Limited flexibility with one prime reuse option (ash use in concrete/asphalt industry)	Limited flexibility with one prime reuse option (dewatered dried biosolids applied to agriculture)	Additional flexibility with options for agriculture application of digested biosolids and landscape use of dried biosolids	Limited flexibility with one prime reuse option (digested biosolids applied to agriculture)	Limited flexibility with one prime reuse option (alkaline stabilized biosolids applied to agriculture)
Reliability	Improved reliability with new equipment	Improved reliability with new equipment	Improved reliability with new equipment, parallel processing trains and storage of digested solids	Improved reliability with new equipment	Improved reliability with new equipment
Operability	Good, one prime process with minimum number of units, will require an ash handling system	Average, one prime process but additional operational attention for dried product storage and marketing.	More difficult with two parallel processes and marketing of two products	Average, one prime process but additional operational attention for gas handling and product storage and marketing.	Average, one prime process but additional operational attention for alkaline stabilized product storage and marketing.

MWWTP Solids Processing Improvement Project
Table 6-1
Nonmonetary Evaluation

Evaluation Factors	Alternatives 1&2 Fluid Bed Incineration	Alternative 3 Heat Dried Low Nitrogen Product	Alternative 4 Heat Dried Quality Product	Alternative 5 Anaerobic Digestion	Alternative 6 Alkaline Stabilization
Maintainability	Low requirements, one prime process with minimum number of units	Average requirements, one prime process but additional maintenance for dried product screens and rollers and large dried product storage facilities.	High requirements, maintenance of two parallel processes with the higher maintenance associated with the dried product trains and low maintenance of anaerobic digestion facilities.	Low requirements, one prime process with minimum number of units.	Low requirements, one prime process with minimum number of units
Safety Impacts	Low, similar process to existing but operators will require training for the fluid bed incineration process, dust from ash must be controlled	High, dusty product and new technology, some potential for explosive conditions, significant operator training will be required with the new drying process	Average, with improved dried product quality, significant operator training will be required with the new drying process, in addition training will be required for anaerobic digestion and handling of digester gas	Average, potential for explosive conditions, training will be required for anaerobic digestion and handling of digester gas	High, dusty product and some potential for explosive conditions
Regulatory Requirements	Regulatory requirements are a significant issue with associated air emissions, but currently does not appear to prevent implementation, reuse of ash will require management to comply with regulations.	Regulatory requirements are a significant issue with associated air emissions, but currently does not appear to prevent implementation, agricultural application of dried product will require management to comply with regulations	Regulatory requirements are a significant issue with associated air emissions, but currently does not appear to prevent implementation, agricultural application of dried and digested products will require management to comply with regulations	Regulatory requirements apply to the application of anaerobically digested biosolids on agricultural lands and will involve extensive records but full regulatory compliance is not an issue	Regulatory requirements apply to the application of alkaline stabilized biosolids on agricultural lands. Production of a Class A product substantially reduces the monitoring and regulatory reporting requirements. Full regulatory compliance is not an issue

Operations and Maintenance (O&M) Costs

Estimates of consumables, which include chemicals, electricity, and natural gas, were based on treating projected loadings in the year 2005. Comparative labor requirements were estimated for the alternatives, based on the number of unit processes and the complexities of operation and maintenance. Costs for marketing residual dried biosolids are incorporated into the net projected revenue estimates. Section 7 and tables in Appendix E present the development of O&M costs.

Life Cycle Costs

Comparing the life cycle costs of alternative capital and annual investments is a way to evaluate their relative economic merits. Life cycle cost is an economic measure of all the costs expected to incur over the life of a project. Since costs may be incurred at different times for alternative projects, life cycle cost analysis involves discounting these future costs to the present, respecting the time value of money. Once these life cycle costs are discounted to the present and added together for each alternative, the alternatives may then be compared to determine the most cost-effective capital investment decision. Life cycle cost is an economic, not a financial, measure of a project's merits. As such, it does not reflect interest on debt or other factors that may directly affect the rates, fees, and charges required to financially support a project.

Life cycle costs for each alternative were determined for a 20-year facility planning period. The life cycle costs were discounted to today's present value (1998). The results for each alternative were then compared. The lowest present value life cycle cost represents the most cost-effective alternative. A second measure was also developed; the equivalent annual cost. It represents the annual annuity (or payment) required to derive the total present value amount by the end of the planning period. Both the present value and equivalent annual cost are economic measures to determine the most cost-effective solids processing technology alternative. Table 6-2 presents a summary of the life cycle costs for each of the six alternatives.

TABLE 6-2
Summary Life Cycle Costs of Facility Planning Alternatives

		Life Cycle Cost ($M)			
Alt.	Description	Capital Cost[a]	Annual O&M Cost[b]	Present Value[c]	Equivalent Annual Cost[d]
1	4 FBIs	215	10.0	300	17.4
2	3 FBIs w/ Alkaline Stabilization[e]	189	10.3	283	16.4
3	Heat Drying (Low Nitrogen Product)	263	11.8	351	20.3
4	Heat Drying (High Nitrogen Product)	263	10.5	335	19.4
5	Anaerobic Digestion	254	11.7	344	19.9
6	Full Alkaline Stabilization	221	11.4	318	18.4

[a] Presented in 1998 dollars. Includes 25 percent for engineering, legal, admin and training and 25 percent for undeveloped design details
[b] Presented in 1998 dollars. Includes ash disposal costs (if appropriate), product revenue (if appropriate) and O&M costs.
[c] Based on a discount rate of 6 percent and an annual inflation rate of 3 percent.
[d] Based on a planning period of 20 years.
[e] The cost estimate for the recommended alternative has been refined following further analysis that was undertaken after this cost comparison was completed. Please refer to Section 3.

Alternative 2, incineration using three FBIs supplemented with an alkaline stabilization process, has the lowest up-front project cost of $189 million. Despite a slightly higher estimated annual O&M cost than Alternative 1 (the next lowest capital cost option), it has the lowest overall life cycle cost of $283 million. Its equivalent annual cost of $16.4 million is also the lowest of the six alternatives.

Conclusions and Recommendation

On July 23, 1998, MCES staff recommended and the Metropolitan Council approved the selection of the energy recovery system, consisting of 3 FBIs, as the primary stabilization technology. Alkaline stabilization was included by the Council as a supplemental stabilization technology for the Metro Plant Solids Processing Improvement Project. The basis for this recommendation is summarized in the following table. The issues presented in the table (monetary, odors, residuals, space, and energy) were acknowledged to be of major significance in considering sustainable alternatives to process solids at the Metro Plant.

Issues	Energy Recovery (Incineration)	Heat Drying	Anaerobic Digestion	Alkaline Stabilization
1. Monetary	Advantage			
2. Odors	Advantage			
3. Residuals (Recycle Organics to Land)		Advantage	Advantage	Advantage
4. Space	Advantage			
5. Energy (Reliance on Fossil Fuels)	Advantage		Advantage	

A number of Metro area citizens that provided input during the evaluation process generally favored a technology that would recycle organics to the land. This was recognized as an important factor in support of land application. However, neighborhood residents near the plant expressed their desire to minimize future odor sources, which supports incineration. The need to minimize costs, to conserve space for future liquids treatment expansion, and to minimize reliance on fossil fuels were also recognized as important issues, which support incineration. After balancing the needs and interests of the region, neighbors, and interested citizens, energy recovery consisting of 3 FBIs with beneficial use of ash, supplemented with alkaline stabilization that produces biosolids for land application from approximately 10% of the solids, was selected as the recommended technology.

Section 7 Economic, Risk, and Financial Assessment

This section presents the results of economic, risk, and financial assessments of the Solids Processing Improvement Project alternatives for the Metro Plant. These assessments were undertaken to support selection of the most appropriate solids stabilization technology as detailed in Section 6 – Alternatives Evaluation.

Capital and Annual Cost Summary

The analyses prepared for this section rely upon capital and annual operating cost estimates for each alternative. Table 7-1 presents capital cost estimates for each of the six alternatives considered in Section 6. These costs include construction plus 25 percent for engineering, administration, legal, training and other contingencies; and 25 percent to account for design details (undeveloped as of the preparation of this facility plan). The capital cost estimate for the recommended alternative was refined following completion of this cost comparison and Council selection of a preferred technology. The refined cost estimate for the recommended alternative is included in Section 3 – Recommended Alternative.

Table 7-2 presents estimated annual operating costs. These include operations and maintenance (O&M), ash disposal costs (if applicable), and revenue from the sale of dried product (if applicable). O&M costs include labor, materials, utilities (natural gas and electricity), and chemicals. O&M costs also include the cost of land application for Alternatives 5 and 6. The operating cost estimate for the recommended alternative was refined following completion of this cost comparison. The refined operating cost estimate is included in Section 3.

TABLE 7-1
Capital Cost Summary of Facility Planning Alternatives

Alt.	Description	Cost ($M)[a] Capital	Engineering, Legal, Admin[b]	Undeveloped Design Details[c]	TOTAL[d]
1	4 FBI	137	34	43	215
2	3 FBI w/ Alkaline Stabilization[e]	121	30	38	189
3	Heat Drying (Low Nitrogen Product)	169	42	53	263
4	Heat Drying (High Nitrogen Product)	168	42	53	263
5	Anaerobic Digestion	162	41	51	254
6	Full Alkaline Stabilization	141	35	44	221

[a] Prepared in 1998$.
[b] Assumed to be 25 percent of the construction cost.
[c] Assumed to be 25 percent of the construction cost plus engineering, legal, admin and training.
[d] Results may differ slightly due to rounding. These capital costs do not consider the possible effects of sales tax exemption legislation that was enacted following completion of this cost comparison.
[e] The capital cost estimate of the recommended alternative has been refined following further analysis that was undertaken after this cost comparison was completed. Please refer to Section 3 of this facility plan.

TABLE 7-2
Annual Operating Cost Summary of Facility Planning Alternatives

Alt.	Description	Annual Cost ($M)[a] O&M	Dried Product Revenue[b]	Ash Disposal Cost[c]	TOTAL
1	4 FBIs	8.7	0	1.3	10.0
2	3 FBIs w/ Alkaline Stabilization[d]	9.1	0	1.2	10.3
3	Heat Drying (Low Nitrogen Product)	12.3	(0.5)	0	11.8
4	Heat Drying (High Nitrogen Product)	10.9	(0.4)	0	10.5
5	Anaerobic Digestion	11.4	0	0	11.4
6	Full Alkaline Stabilization	11.7	0	0	11.7

[a] Presented in 1998$.
[b] Assumed to be $7.83 per dry ton for high nitrogen product and $5.00 per dry ton for low nitrogen product (1998$).
[c] Assumed to be $53.00 per ton (1998$).
[d] The estimated annual operating cost for the recommended alternative has been refined following further analysis that was undertaken after this cost comparison was completed. Please refer to Section 3.

Economic Assessment

The purpose of the economic assessment is to compare each alternative's total costs throughout a defined facility-planning period. For this facility plan, a life cycle cost methodology was used to compare the total costs of each alternative. Comparing the life cycle costs of alternative capital investments evaluates relative cost-effectiveness, balancing both up-front capital and annual operating costs.

Life Cycle Costs

Life cycle cost is an economic measure of all of the costs expected to be incurred over the life of a project. Since costs may be incurred at different times for each alternative, life cycle cost analysis involves discounting these future costs to the present, respecting the time value of money. Once these life cycle costs are discounted to the present, the alternatives may then be compared to determine the most cost-effective capital investment decision. Life cycle cost is an economic, not financial, measure of a project's merits. As such, it does not reflect interest on debt or other factors that may directly affect the rates, fees, and charges required to financially support a project.

Methodology

Life cycle costs typically include: 1) up-front capital costs; 2) ongoing annual O&M costs; 3) revenues expected to be derived from the project, if any; 4) periodic replacement costs in accordance with each component's expected useful life; and 5) the terminal value of each component at the end of the planning period.

Life cycle costs for each alternative were determined for a 20-year facility-planning period (2005 through 2025). The life cycle costs were discounted to today's present value (1998). The lowest present value life cycle cost represents the most cost-effective alternative. An equivalent annual cost was also developed, which represents the annual annuity (or equal annual payment) required to derive the present value amount by the end of the planning period. Both the present value and equivalent annual cost are economic measures to determine the most cost-effective solids processing technology alternative.

Assumptions

Project costs have been developed in 1998 dollars; however, life cycle cost analysis takes an inflationary perspective. Therefore, O&M costs are first escalated using an annual inflation rate and are then discounted back to 1998. Construction is assumed to commence in 2002, with operations to commence in 2005. Undeveloped design details are assumed to be 25 percent of construction costs. Engineering, legal, administration, and other contingencies are assumed to add an additional 25 percent to the project cost. Forecasted future costs reflect an assumed annual inflation rate of 3 percent. A discount rate of 6 percent was used to determine a 1998 present value for each alternative.

A replacement cost factor of 150 percent has been assumed for the replacement of facility components that are expected to wear out during the 20-year planning period. This reflects the future cost (in addition to inflation) to replace a piece of equipment that has reached the end of its useful life and must be replaced with a similar model, often from the same manufacturer. The factor reflects normal procurement and installation costs required to replace a specific piece of equipment in a functioning facility.

Revenue from dried product is assumed to be $7.83 per ton (1998 dollars) for a high-nitrogen product, net of marketing costs. High-nitrogen product is defined as 5 to 6 percent nitrogen. It is assumed that some early efforts would be undertaken to develop a market for dried product so that all of the product could be sold when the facility comes on-line in 2005. Revenue from low-nitrogen dried product is assumed to be $5.00 per ton (1998 dollars), net of marketing costs. Low-nitrogen product is defined as 4 to 5 percent nitrogen. Ash disposal costs are assumed to be $53.00 per ton (1998 dollars) based on MCES's present cost to dispose of its ash.

O&M costs are comprised of labor, utilities, chemicals, end-product disposal, and maintenance. Operations labor costs are based on the 1998 average cost per full-time employee (FTE) of $68,500 per year including benefits. Utilities and chemicals costs are based on information previously compiled for the Metro Plant Master Plan (December 1996), adjusted to 1998 dollars. Maintenance costs include a materials component that is assumed to be 3 percent of the original equipment cost.

Comparison of Facility Planning Alternatives

Table 7-3 presents a summary of the life cycle costs for each alternative. Alternative 2, incineration using three fluid bed incinerators (FBIs) supplemented by alkaline stabilization for peak or downtime loading, has the lowest up-front project cost of $189 million. Despite a slightly higher estimated annual O&M cost than Alternative 1 (the next lowest capital cost option), it has the lowest overall life cycle cost of $283 million. Its equivalent annual cost of $16.4 million is also the lowest of the six alternatives.

TABLE 7-3
Summary Life Cycle Costs of Facility Planning Alternatives

		Life Cycle Cost ($M)			
Alt.	Description	Capital Cost[a]	Annual O&M Cost[b]	Present Value[c]	Equivalent Annual Cost[d]
1	4 FBIs	215	10.0	300	17.4
2	3 FBIs w/ Alkaline Stabilization[e]	189	10.3	283	16.4
3	Heat Drying (Low Nitrogen Product)	263	11.8	351	20.3
4	Heat Drying (High Nitrogen Product)	263	10.5	335	19.4
5	Anaerobic Digestion	254	11.7	344	19.9
6	Full Alkaline Stabilization	221	11.4	318	18.4

[a] Presented in 1998 dollars. Includes 25 percent for engineering, legal, admin and training and 25 percent for undeveloped design details

[b] Presented in 1998 dollars. Includes ash disposal costs (if appropriate), product revenue (if appropriate) and O&M costs.

[c] Based on a discount rate of 6 percent and an annual inflation rate of 3 percent.

[d] Based on a planning period of 20 years.

[e] The cost estimate for the recommended alternative has been refined following further analysis that was undertaken after this cost comparison was completed. Please refer to Section 3 of this facility plan.

Appendix F presents a detailed life cycle cost analysis. For each alternative, capital cost, replacement cost, terminal value, and O&M cost are developed and reported.

The first table in each series includes an analysis of the present value of the capital cost of the project. An itemized list of each project component is presented, along with its estimated 1998 cost, the type of item (e.g., structure, equipment), expected initial year of expenditure, the year of operation (2005), and expected draw-down throughout the 2002 to 2004 construction period. The escalated cost (reported in the year of construction assuming a 3 percent annual rate of inflation) is then presented along with its 1998 present value.

In the second table in each series, replacement costs are developed for each item. Based on assumed useful lives, periodic replacements are scheduled over the planning period. The escalated costs and corresponding 1998 present values of these replacement costs are reported in the two columns at the left side of each table.

In the third table in each series, the terminal value for each item is developed. The life cycle cost reflects the value of the project at the end of the planning period. For facility planning purposes, the planning period is defined as 20 years. The 20-year planning period begins in 2005. The planning period is different than the 25-year planning period used in the Metro Plant Master Plan. Several project components are expected to have a useful life of up to 50 years. The remaining values at the end of the planning period are deducted from the total life cycle cost. For each series, this table presents the item's description, its useful life, the remaining useful life at the end of the planning period, and the terminal value in future dollars. The column on the far left then reports the 1998 present value of that future terminal value.

The fourth table in each series presents O&M costs, end-product disposal costs, and total life cycle costs. O&M costs are presented in 1998 dollars, and the expected annual costs when the facility comes on-line (2005) are also provided. In the far left, the 1998 present value of O&M costs are developed. The present value reports the total value, in 1998 dollars, of the stream of future expected costs required to operate and maintain the facility over the planning period.

The total life cycle cost is the sum of the 1998 present values of the capital cost, replacement cost, terminal value, and stream of future O&M costs of the project. Since this life cycle cost is reported in present (1998) dollars, these may be compared to judge the relative economic merits of each technology alternative.

Sensitivity Analysis

Table 7-4 presents the annual costs for each project alternative if dried product revenue and ash utilization cost assumptions were changed. The table presents several scenarios. The first series illustrate the changes in total annual cost in response to different assumptions regarding the revenue produced from sales of dried product. The amount of revenue received from the sale of high quality dried product was assumed to: 1) increase by 200 percent to $23.49 per dry ton; 2) increase by 100 percent to $15.66 per dry ton; 3) decrease by 50 percent to

$3.92 per dry ton; and 4) decrease by 75 percent to $1.96 per dry ton. The amount of revenue received from the sale of low quality dried product was also assumed to: 1) increase by 200 percent to $15.00 per dry ton; 2) increase by 100 percent to $10.00 per dry ton; 3) decrease by 50 percent to $2.50 per dry ton; and 4) decrease by 75 percent to $1.25 per dry ton. Even if the revenue were to increase by 200 percent, the three FBI alternative (Alternative 2) still offers the lowest equivalent annual cost.

The second series of scenarios, presented in Table 7-5, illustrate the changes in total annual cost in response to changes in the cost to beneficially utilize incinerator ash. The ash disposal cost was assumed to 1) increase by 200 percent to $159.00 per ton; 2) increase by 100 percent to $106.00 per ton; 3) decrease by 50 percent to $26.50 per ton; and 4) decrease by 75 percent to $13.25 per ton. If the cost to dispose of ash were to increase by over 200 percent, the three FBI (Alternative 2) and full alkaline stabilization (Alternative 5) alternatives would offer roughly equivalent annual costs.

TABLE 7-4
Sensitivity Analysis Summary – Impact on Equivalent Annual Cost due to Changes in Dried Product Revenue Assumptions

Alt.	Base Case	Changes from base $7.83 per dry ton revenue and $5.00 per dry ton revenue (1998$)			
		+200%	+100%	-50%	-75%
1	17.4	17.4	17.4	17.4	17.4
2	**16.4**	**16.4**	**16.4**	**16.4**	**16.4**
3	20.3	19.7	20.0	20.5	20.6
4	19.4	18.8	19.1	19.6	19.7
5	19.9	19.9	19.9	19.9	19.9
6	18.4	18.4	18.4	18.4	18.4

TABLE 7-5
Sensitivity Analysis Summary – Impact on Equivalent Annual Cost due to Changes in Ash Disposal Cost Assumptions

		Changes from base $53.00 per ton cost (1998$)			
Alt.	Base Case	+200%	+100%	-50%	-75%
1	17.4	19.2	18.3	16.9	16.7
2	**16.4**	**18.1**	**17.3**	**16.0**	**15.8**
3	20.3	20.3	20.3	20.3	20.3
4	19.4	19.4	19.4	19.4	19.4
5	19.9	19.9	19.9	19.9	19.9
6	18.4	18.4	18.4	18.4	18.4

Comparison of Master Planning Alternatives

The original Metro Plant Master Plan alternatives were re-evaluated using the life-cost methodology used for this facility plan. The capital and annual O&M costs for each alternative are reported in the Master Plan. Based on that analysis, the relative present worth ranking of the Master Plan alternatives did not change. Based on the updated methodology and original Master Plan costs, fluid bed incineration and heat drying continue to be the two most cost-effective technologies.

Financial Assessment

The purpose of the financial assessment is to describe the planned financial resources to be used to fund the facility planning alternatives.

Projected Drawdown during Construction

To put the capital and O&M cost estimates into a financial planning perspective, it is necessary to escalate the cost estimates to the year in which these costs are planned to be incurred. Table 7-6 presents the projected drawdown of funds during the planned 3-year construction period, 2002 through 2004. These drawdowns are based on an assumed annual inflation rate of 3 percent and estimates of the phasing of construction of each facility component. Table 7-6 suggests that about 50 percent of the total project cost will be incurred during the second year of construction, or 2003.

TABLE 7-6
Projected Draw-Down for Facility Planning Alternatives

			Project Cost ($M) Inflation-Adjusted		
Alt.	Description	Capital Cost[a]	2002	2003	2004
1	4 FBIs	249	75	125	49
2	3 FBIs w/ Alkaline Stabilization	219	66	110	43
3	Heat Drying (High Nitrogen Product)	306	92	153	61
4	Heat Drying (Low Nitrogen Product)	306	92	153	61
5	Anaerobic Digestion	294	88	147	59
6	Full Alkaline Stabilization	256	77	128	51

[a] Presented in escalated dollars, assuming forecasted annual inflation rate of 3 percent.

Planned Project Funding

Independent of the selected technical alternative, funding for the Solids Processing Improvement Project is planned to be from long-term bonds and loan proceeds.

Bond Financing

The proceeds of bonds issued in 2002 and 2003 are planned to be the primary funding source for the capital costs to be incurred in 2002 through 2004. Financing would be coordinated through a unified capital improvement program (CIP). MCES issues bonds either directly or through the Public Facilities Authority (PFA).

The Council is authorized under State statutes to issue debt to support regional wastewater programs. The unified CIP schedules debt issuance over a multi-year period in consideration of available resources, prioritized capital needs, and the region's ability to pay as measured by property tax growth and personal income projections. The Council is required by State statute to adopt a CIP and Annual Capital budget for expenditures for major equipment, facilities, and land. The CIP covers a 5-year period. It is planned that the Metro Plant Solids Processing Improvements Project will become a part of that CIP. As of this writing, a unified 1999 to 2003 CIP is being developed and will be presented to Council for consideration in the third quarter of 1998.

Annual debt service payments supporting these bond proceeds are paid for from wastewater service charges and service availability charges (SAC).

Wastewater Service Charges

Wastewater service charges support the activities of MCES. This funding source is planned to support the O&M cost of the Metro Plant Solids Processing Improvement Project as well as most of the debt service on bonds issued to finance its construction. Wastewater service charges are based on the volume of flows generated from customer communities.

In 1997, $95.0 million in wastewater service charges were collected, just above the $92.5 million in budgeted revenue (1998 amended budget). The 1999 proposed budget includes $82.4 million in wastewater service charges, representing a 10.98 percent decrease over the 1998 amended budget.

Service Availability Charges

The SAC fee is similar to "connection fees" used by many wastewater utilities. SAC fees are charged MCES through its customer municipalities for new connections to the Metropolitan Disposal System (MDS) and to existing industrial customers for increased volumetric usage. SAC revenues pay a portion of debt service on outstanding debt in accordance with a determination of the "reserve capacity" in the MDS.

SAC fees fulfill the requirements of Minnesota Statute, MS 473.517, and are collected from all new customers connecting to the MDS owned and operated by the Metropolitan Council. These revenues are used to pay a portion of annual debt service payments on those loans and long-term debt obligations of the Metropolitan Council that have funded capital investment in the MDS. Wastewater volume charges, SAC revenues, and other available revenues from the Council's wastewater operations support these obligations. While SAC is a contingent revenue source, it has been and continues to be a reliable source of revenue made on behalf of future sewer users in the Twin Cities region.

In fiscal year 1997, the SAC program generated revenues sufficient to fund that portion of debt service payments defined by the "reserve capacity" in the wastewater interceptor and treatment system. SAC fees of $950 per unit paid by 19,269 connecting SAC units (net of credits) generated fee revenue of $18,018,939. These revenues were sufficient to fund $15,918,927 in debt service payments. The remainder was deposited into the SAC reserve fund that had a balance of $74.2 million as of year-end 1997.

In 1998, the basic SAC fee increased by $50 to equal $1,000 per unit. An estimated 15,070 SAC units (net of credits) are expected to generate $14,919,000 in fee revenues (net of local retainage). If those projections are accurate, an estimated $3,585,000 will be withdrawn from SAC reserves to pay $18,504,000 in debt service obligations.

It is expected that MCES will have sufficient wastewater service charge revenues and SAC reserves to financially support the debt service resulting from the Metro Plant Solids Processing Improvement Project.

Industrial Pre-Treatment Program and Charges

MCES administers an industrial pretreatment program to monitor and regulate the discharge of high-strength wastewater into the MDS. Industrial waste is defined as any waste resulting from an industrial, manufacturing, commercial or business activity; or from the development, recovery, or processing of a natural resource. Industrial waste includes leachate, contaminated groundwater, hauled waste, and contact cooling water. Industrial waste may have higher strength and pollutant levels than domestic waste. To regulate the discharge of industrial waste into the MDS, MCES administers a program of industrial discharge permits. These are individual control mechanisms that specify the standards and conditions through which industrial waste may be discharged into the MDS. The permit includes reporting and monitoring requirements. Annual permit fees are required.

Industrial waste charges represent the extra cost of treating higher strength wastewater discharged into the MDS. This charge applies to permitted industrial users, waste transport haulers, and other special high-strength discharges. Strength charges are based on the amount of total suspended solids (TSS) and chemical oxygen demand (COD) present in the wastewater above normal or base concentrations. Based concentrations are defined as 250 mg/L TSS and 500 mg/L COD. In 1997, MCES collected $8,406,000 in industrial waste strength charge revenues. Its 1998 amended budget included $8,470,000 and its proposed 1999 budget included $8,324,000 in such charges.

Risk Assessment

A qualitative assessment of the risks inherent in each of the solids processing technologies was undertaken. The purpose of the assessment was to evaluate the risk issues associated with each technology to be able to weigh both monetary and non-monetary aspects of each so that the most appropriate processing technology could be selected.

The overall objective of the Metro Plant Solids Processing Improvement Project is to continue to process solids in a manner that maximizes stakeholder value. Stakeholders to the project include the Council, residents who live near the Metro Plant, other residents in the region, MCES employees and plant operators, and regulatory agencies.

To maximize stakeholder value, the following policy objectives need to be considered.

- Maintain Health & Safety
- Protect the Environment
- Ensure Acceptance by the Public
- Ensure Future Financial Performance
- Meet Future Regulations
- Ensure Operability
- Minimize Employee Impacts

In considering the risks to achieve each of these policy objectives, three specific types of risks emerged as the most critical to the selection of an appropriate processing technology: changes in regulations, marketing of residuals, and generation and management of odors. These are described in more detail below.

Changes in Regulations

The first type of risk that bears on the selection of an appropriate processing technology is related to unanticipated changes in regulations. Dramatic changes in solids processing regulations could potentially have immediate and substantial monetary impacts to the facility. The most critical changes would be to regulations governing air emissions from incinerators and those governing the land application of biosolids.

More restrictive air emissions regulations would likely create the need to add additional air pollution control equipment that would increase the cost of the solid processing facilities at the Metro Plant. Alternatives 1 and 2 include control equipment in anticipation of future regulations. Even if future regulations were more onerous, the risk of total failure of the technology confronted by such regulatory changes is remote. Disposal of incinerator ash does not seem to pose a significant risk since the MCES has developed and maintained a market for many years. Further, there is the potential to develop other markets that may even reduce current costs.

Market Risks

The second type of risk that bears on the selection of an appropriate processing technology are those related to the markets for biosolids. Alternatives 3 through 6 require creating and maintaining large markets for biosolids. These markets must be diverse enough to accommodate long winters and sporadic limitations due to wet weather and growing seasons. Alternative 3 produces a low-nitrogen heat dried product that is often sold to farmers or to specialty blending operations. Alternative 4 produces a high-nitrogen heat dried product that would enter the same markets. The risk here is not that revenue estimates from material sales are too optimistic, but that the material must be landfilled due to the inability to find any end-market, regardless of price. Although work completed for this Facility Plan confirmed that such a market could be developed, it is a risk factor nonetheless. The risks here are exacerbated due to the large volume of material produced at the Metro Plant.

Alternative 5 produces a stabilized biosolids material through an anaerobic digestion process for direct application to agricultural land. Such material, regarded as Class A for regulatory purposes, also requires developing and maintaining a substantial program to administer the application sites and related regulatory reporting requirements. Some counties and townships have banned the application of such material due to concerns about groundwater contamination. As with Alternatives 3 and 4, the risks are directly related to the inability to dispose of the material by any means than to incur some unexpected additional cost. The risks are exacerbated due to the large volume of material produced at the Metro Plant.

Alternative 6 produces an alkaline stabilized biosolids material for direct application to agricultural land. Such material, regarded as Class A for regulatory purposes (with windrowing to allow sufficient curing time), requires developing and maintaining a substantial program to administer the application sites and related regulatory reporting requirements. In some cases, counties and townships have banned the application of such material due to concerns about groundwater contamination. As with Alternatives 3 to 5, the risks here are more related to the inability to dispose of the material by any means than to incur some unexpected additional cost. The risks here are similarly exacerbated due to the large volume of material produced at the Metro Plant. Alternative 2 includes some production of an alkaline stabilized biosolids material; however, the risks are deemed not as significant due to the limited quantities produced.

Odor Generation and Management

The third type of risk, which bears on the selection of the most appropriate technology, is the generation and management of odors. Alternatives 1 and 2, which include incineration of all or the majority of the solids, generate fewer odors. Odors generated as part of the incineration process are readily eliminated prior to discharge through the stacks. Alternatives 3 through 6 involve stabilization processes that generate significantly more odors that have to be actively managed. Further, these odors would be generated at diverse locations at the Metro Plant, resulting in an elevated risk that odors might escape into the ambient atmosphere. Therefore, it is concluded that Alternatives 1 and 2 provide somewhat lower risks of detectable odor offsite. Regarding Alternative 2, the production of a small amount of alkaline stabilized biosolids material is not likely to substantially increase the risk of detectable, offsite odors.

Conclusions

Based on evaluation of these risks, it is concluded that there is a slight advantage to incineration (Alternatives 1 and 2). The risks due to changes in regulations are judged to be similar. The risks due to market failure are judged to be of much more concern for those alternatives that include large land application or heat drying programs.

Section 8 Existing Solids Processing Facilities

Summary

The purpose of this section is to summarize the condition of the existing (1998) solids processing facilities at the Metro Plant. A detailed description of the existing solids processing facilities can be found in the Metro Plant Master Plan (December 1996).

Approximately one-half of the annual operation and maintenance (O&M) costs of the plant are attributed to the solids processing facilities. This is partly due to aging equipment, which requires frequent maintenance, and the overall operational complexity of the existing unit processes. When the facility planning period begins in year 2005, the majority of the solids processing unit processes will be approximately 25 years old. For some equipment, it will be 25 years since it was last rebuilt (e.g., incinerators).

Although the existing solids processing facilities have adequate capacity to meet the solids processing requirements through the planning period (year 2025), the increasing frequency of equipment failures require major unit processes to be taken out of service for repair or replacement. This action will jeopardize the plant's ability to meet projected peak loading conditions through the planning period.

As a result of the age and condition of the existing solids processing facilities, this Facility Plan is being developed to investigate alternatives to reliably meet the Metro Plant solids processing needs.

Overview and History

Solids management at the Metro Plant has been based on solids incineration since the original facilities were built in 1938. These original facilities consisted of chemical conditioning with lime and ferric chloride, dewatering with vacuum filters, incineration, and land filling of the ash into ash lagoons. The plant expansion and upgrade to secondary treatment in the1960s included expansion of the solids system to handle waste activated solids (WAS). The expansion also included gravity thickeners and solids holding tanks, additional chemical conditioning, and dewatering and incineration facilities. The 1972 plant expansion included the addition of one incinerator.

Major process changes were made in the solids processing facilities by 1980, when dissolved air flotation (DAF) thickeners were installed to thicken WAS and thermal conditioning replaced the chemical conditioning process. The addition of thermal conditioning included the associated return liquor treatment facilities and solids storage tanks. Filter presses were installed to produce a high solids cake from the thermally conditioned solids. By late 1982, construction was nearly complete for roll presses (primary solids dewatering), two new incinerators, and modifications to four incinerators, solids dryers, waste heat boilers on four incinerators, and dry ash handling and storage silos for ash and dried product. With the exception of the filter presses and dryers, the above facilities constitute the existing solids processing facilities at the Metro Plant. A block diagram of the existing solids processing facilities is shown on Figure 8-1.

The following sections summarize the condition of the existing solids processing facilities.

Scum Treatment

Primary scum is pumped from the primary clarifiers to three scum decant tanks. Concentrated scum is skimmed from the decant tanks and stored in heated scum storage hoppers. Scum from each storage hopper passes through grinders before being pumped to the multiple hearth incinerators.

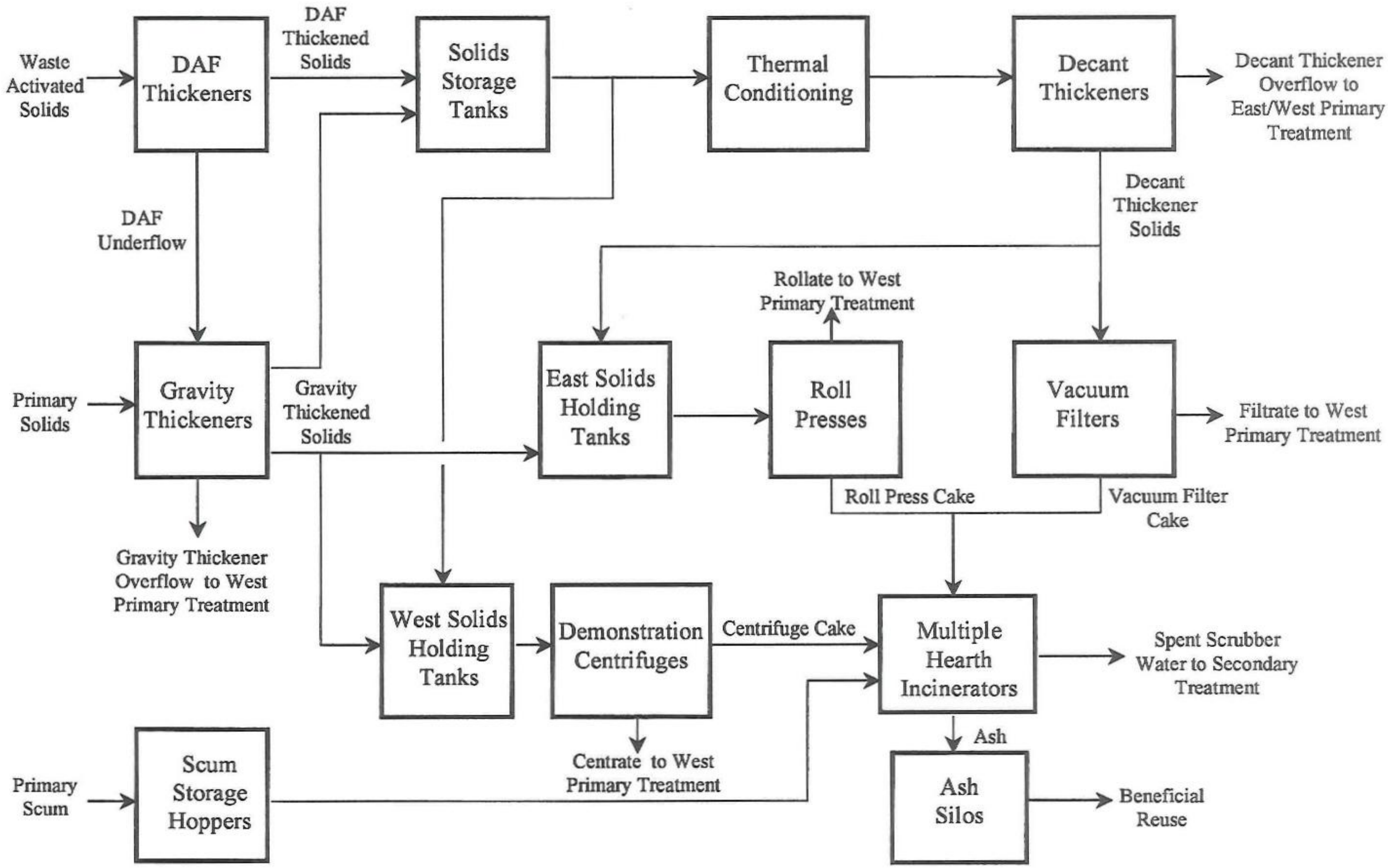
Gravity Thickeners

Six gravity thickeners provide thickening of the primary solids from the east and west primary tanks, as well as other solids from various sidestreams. Although the gravity thickening process has achieved its primary process objective, the following concerns have been expressed:

- Primary instrumentation problems related to flow measurement and representative sampling.
- With interruptions in downstream solids processing, thickened solids must be stored until normal processing can be resumed. Under these circumstances, the gravity thickeners are used for both thickening and storage. The solids in the gravity thickeners can become septic, which is a source of odors and affects dewatering capacity.
- Rags in the solids have caused problems in the performance of the plunger-type thickened solids pumps and downstream solids processes.
- Odor generation could require the gravity thickeners to be covered and the odorous air scrubbed in the future.
- The gravity thickeners are in a physically confined location. Any expansion of thickeners in this area would require relocation of the vehicle maintenance building.
- Water must be added to thickened solids to accommodate pumping, particularly in winter.

In general, the gravity thickening equipment is subject to harsh conditions and has a remaining life of approximately 10 years.

Figure 8-1
Solids Processing Block Diagram



Flotation Thickening

DAF thickeners are used to thicken WAS prior to dewatering. Final settling tank scum is also sent to these units for thickening with the WAS. The thickened WAS is pumped to the solids storage tanks.

The sixteen DAF thickeners are arranged in four sets of four units. When originally installed, one-half of the units were in service during summer months and all units were in service during the winter months. In the early 1980s, the plant switched to full-time nitrification allowing the plant to use only half of the DAF thickeners year round.

Only minimal preventive maintenance has been performed on mechanical equipment in this area of the plant. With the exception of the recycle pumps, all equipment in this area was installed in 1979. The majority of equipment has 5 to 15 years of remaining life.

Solids Storage Tanks

The solids storage tanks receive flotation thickened WAS and gravity thickened primary solids. Combined solids from these tanks are normally pumped to thermal conditioning. The eight solids storage tanks were placed into service in the early 1980s and are located adjacent to the thermal conditioning facilities.

Past problems with the location of the air diffusers in the tanks led to the removal of some of the diffusers in 1995. The original longitudinal solids collector equipment has also been removed. Consequently, tank mixing is not effective. The structural remaining life of these tanks is estimated to be 40 years.

Thermal Conditioning

Eight Zimpro® wet air oxidation units perform thermal solids conditioning. Thickened WAS and thickened primary solids are gravity fed from storage tanks to grinders. The ground solids are fed to centrifugal pumps which deliver solids to high-pressure pumps. Each high-pressure pump discharges the ground solids to a series of stainless steel heat exchangers and a reactor. High-pressure steam and air are added to the solids in the reactor to achieve operating conditions of 375°F at 330 psi. Conditioned solids are transferred to decant tanks prior to dewatering.

The thermal conditioning process requires highly skilled operations and maintenance attention. Most of the equipment, with the exception of the decant tank underflow pumps, dates to the original 1980 construction project. The original decant tank underflow pumps were replaced in 1986. The outside nitric storage tank and indoor chemical transfer pumps were added in 1984.

The high-pressure pumps require rebuilding approximately every 1,000 hours, and the heat exchangers are routinely taken out of service for inspection and preventative maintenance. Remaining equipment life generally varies from 5 to 10 years.

Return Liquor Treatment Facilities

The rotating biological surface (RBS) process previously treated decant tank overflow, flotation thickener underflow, and spent nitric acid. Due to significant system deterioration resulting from harsh operating conditions, the RBS process has been permanently removed from service and abandoned in place. As a result, the decant tank overflow is now conveyed directly back to the liquid treatment processes without pretreatment, resulting in higher organic loading to the secondary treatment system.

Dewatering

Dewatering is necessary to produce a dry solids cake suitable for incineration by the multiple hearth incinerators. Most of the thermally conditioned solids are blended with gravity thickened primary solids for dewatering by roll presses. The remainder of the thermally conditioned solids is dewatered by vacuum filters. A portion of the thickened WAS and thickened primary solids bypasses the thermal conditioning process and is dewatered by high solids centrifuges. The centrifuges are part of a demonstration project.

Twelve vacuum filters were originally installed in the late 1960s. Four of these units were removed in the 1980s and four roll press dewatering units were installed. In the early 1980s, eight plate and frame presses were installed in an attempt to further enhance dewatering capabilities. This allowed all of the vacuum filters to be decommissioned. Unfortunately, the plate and frame presses failed to perform as designed, and the four vacuum filters were reactivated to replace the presses.

Four roll presses, four vacuum filters, and two demonstration centrifuges are currently used to dewater solids. The remaining four vacuum filters and the plate and frame presses have been abandoned in place. The roll presses and vacuum filters have provided satisfactory performance for the Metro Plant. Process concerns expressed by plant staff include:

- The solids cake feed conveyors to the incinerators have limited flexibility that can result in a reliability problem. For example, the loss of conveyor 2B impacts four incinerators and/or three roll presses.
- Dewatered cake processing is affected by the downstream incineration process. Under normal conditions, unanticipated incinerator problems result in a reduction of dewatering system capability, requiring increased solids storage. If the situation is severe, solids can be dewatered and loaded out of the building via conveyors. Once loaded out, there is no mechanism to feed the dewatered solids back to the incinerators, thus requiring an alternate disposal method.
- The filtrate pumps that receive roll press rollate and vacuum filter filtrate are in poor condition. The pumps are located in a physically confined space and have been subjected to a corrosive atmosphere. The pumps also experience plugging from rags passing through the system.
- Only one vacuum pump is in service for the vacuum filters, with the three remaining units having been removed from the area. A second vacuum pump is required to improve vacuum filter system reliability.

Incineration System

The incineration system for dewatered solids cake includes six multiple hearth furnaces (MHF), four of which are equipped with waste heat recovery boilers. The furnaces are sequentially numbered from 5 through 10. Furnace Nos. 5, 6, and 7 were originally constructed in the mid-1960s as 11-hearth units. Furnace No. 8 was constructed in the late 1960s as an 11-hearth unit. Furnace Nos. 9 and 10 were constructed in the early 1980s as 9-hearth units and were supplied with waste heat boilers and venturi scrubber/subcoolers. At this time, furnace Nos. 5, 6, 7, and 8 were also converted to 8-hearth units, and waste heat boiler systems were added to furnace Nos. 7 and 8.

Two auxiliary boilers, both equipped to fire natural gas or fuel oil (with provisions to be converted to coal firing), were installed in the early 1980s as backup units to the waste heat boilers. These boilers are operated intermittently to supplement the steam produced in the waste heat boilers.

The six MHFs are in good condition as a result of attentive maintenance and timely repair. Each furnace system is shut down at 2-month intervals for a hot day-long maintenance check-out and minor repairs. In addition, each system is annually shut down for an extended period of repair and maintenance.

The MHFs do experience uncontrolled intermittent discharges to the atmosphere through the emergency stacks whenever incinerator pressure goes positive or any other system component fails. This is a current issue with regulatory agencies and is a difficult and costly item to address.

A review of the 1994 operating data revealed that two of the four waste heat recovery equipped systems were shut down for extended annual maintenance periods, totaling over 13 weeks during peak or near peak steam demand periods. Due to these shutdowns, the steam load was carried by the auxiliary boilers, primarily burning purchased natural gas. The total system downtime for the four waste heat recovery equipped systems was over 31 weeks. Experience with comparable combustion systems shows that this is an excessive amount of downtime.

As with any large mechanical system, continuous replacement and repair of components and subsystems would make the system life appear to be unlimited. In reality, such a program does not recognize the end of useful life and results in excessive maintenance costs and system downtime.

Section 9
Flows and Loads

Projected Flows and Loads

Flow and load projections for the Metro Plant were developed as part of the MWWTP Preliminary/Primary Improvement Project, Project Number 970620. The technical memorandum "Plant Flows and Loads Basis of Design" (Brown and Caldwell, June 1998) documents influent and recycle flow and load characteristics, and projects future flows and loads through 2040.

Flows and loads were projected for annual average, peak month, and peak week conditions. Table 9-1 shows these conditions for the startup year 2005 through the design year 2025. The projections are based on plant process stream data for the period 1988 through 1997.

TABLE 9-1
Projected Metro Plant Flows and Loads[a]

Year	2000	2005[b]	2010	2020	2025[b]
Flow (mgd)					
Annual Average	225	233.5	242	257	261
Peak Month	293	304	315	334	340
Peak Week	338	350.5	363	385	392
BOD (klb/day)					
Annual Average	432	451	470	498	496.5
Peak Month	502	521	540	568	566.5
Peak Week	597	618	639	670	667.5
TSS (klb/day)					
Annual Average	435	456	477	509	508.5
Peak Month	535	556	577	609	608.5
Peak Week	620	643	666	701	699.5
NH_3-N (klb/day)					
Annual Average	33.1	34.45	35.8	38.2	38.6
Peak Month	38.3	39.9	41.5	44.3	44.7
Peak Week	42.0	43.75	45.5	48.5	49.0
TKN (klb/day)					
Annual Average	55.7	58	60.3	64.3	65.0
Peak Month	64.0	66.65	69.3	74.0	74.7
Peak Week	83.5	86.95	90.4	96.5	97.5
TP (klb/day)					
Annual Average	12.0	12.5	13.0	13.9	14.1
Peak Month	14.4	15	15.6	16.6	16.8
Peak Week	19.2	20	20.8	22.2	22.5

[a] Based on data from MWWTP Preliminary/Primary Treatment Project Task 5150, Plant Flows and Loads Basis of Design, Brown and Caldwell, June 1998.
[b] 2005 and 2025 values calculated by interpolation.

Projected Solids Production

Solids production projections were developed as part of the MWWTP Preliminary/Primary Improvement Project. In the technical memorandum "Sludge Production Projections" (Brown and Caldwell, July 1998), the results of mass balance modeling with and without side-stream treatment for the years 2005, 2025, and 2040 are presented for annual average, peak month, and peak week conditions.

Solids Characteristics

The solids concentration of the gravity thickened primary solids is expected to range from 5.0 percent to 7.5 percent by weight, with 6.5 percent to be used for the design value. Flotation thickened waste activated solids are expected to range from 3.0 percent to 4.5 percent by weight, with 3.5 percent to be used for the design value. The proportion of gravity thickened solids to total solids is expected to range from 40 percent to 90 percent by weight, with 65 percent gravity thickened solids to be used.

In 1997, 25 percent of the secondary treatment system was converted to biologically remove phosphorus. The balance of the secondary system will be converted in the future. Solids processing improvements will require consideration of processing to prevent release of phosphorus.

Solids from Other Sources

Liquid solids from the Hastings, Stillwater, and Cottage Grove Wastewater Treatment Plants (WWTPs) are currently hauled to the Metro Plant for processing. The major expansion to serve South Washington County at the Cottage Grove WWTP site is scheduled to be completed in 2002. Initially, liquid solids will be hauled from this facility to the Metro Plant. Long-range plans include dewatering facilities and hauling a dewatered solids cake to the Metro Plant. Solids projections from other plants hauling solids to the Metro Plant are 12 dry tons per day (dtpd) in 2010 and 19 dtpd in 2015.

Basis of Design

The total solids quantities used as a basis of design for the startup year 2005 and design year 2025 are shown in Table 9-2. The values are based on the solids projections for the Metro Plant, with allowances included for solids hauled to the plant from other sources. These quantities were used for the recommended alternative facilities sizing and refined cost estimate.

TABLE 9-2
Projected Solids Quantities[a]

	Year 2005			Year 2025		
Source	**Annual Average**	**Maximum Month**	**Peak Week**	**Annual Average**	**Maximum Month**	**Peak Week**
Solids Produced at Metro Plant (dtpd)[b] .	252	298	344	279	325	372
Solids Hauled From Hastings, Stillwater, and S. Washington County (dtpd)	13	15	17	20	23	26
Total Solids to be Processed at Metro Plant (dtpd)	265	313	361	299	348	398

[a] Quantities shown are total solids entering stabilization.
[b] Based on data from MWWTP Preliminary/Primary Improvement Project, Task 5150, Solids Production Projections, Brown and Caldwell, June 1998.

Section 10
Public Participation

Public participation from all interested stakeholders was encouraged throughout the facility planning stage for the Metro Plant Solids Processing Improvement Project. Educating stakeholders about the need for a new solids processing facility as well as the benefits of a new facility was the first public communications goal. To accomplish this goal, MCES used various communication tools to contact internal and external stakeholders during the first 6 months of the facility planning process. Following this initial public participation, the Council set a public hearing to receive comments on staff's technology recommendation. Following the hearing, MCES staff continued to work closely with concerned citizens and groups, and the Council continued to receive public input during workshops and meetings until the Council made its technology decision on July 23, 1998.

Initial Public Participation: August 1997-March 1998

External stakeholders were identified to inform about the need for and benefits of the new solids processing facility. These stakeholders included: residential neighbors, business neighbors, municipalities (customers), state and federal regulators, legislators, environmental groups, and the metropolitan-wide business and residential community.

Internal stakeholders were also identified including Council members, MCES staff, Metro Plant staff, and other Council staff.

External Public Participation

To reach external stakeholders, various meetings were set, information packets developed, individual phone calls made, and mailings developed. The formal meetings listed below were held with the various stakeholder groups. For each meeting, phone calls were made to identify as many potential stakeholders as possible to include in a comprehensive mailing list for informing the public during key decision points on the Project.

Community Meetings

Citizen and city representatives of outer service areas and the inner metro area were convened to test communications tools and to provide feedback on perceptions regarding wastewater treatment, processing technology, and rates. More than 200 contacts were made. Forty city administrators or representatives attended the meetings.

Business Community

Meetings were held with the Minnesota Chamber's Water Quality Task Force, the Greater Minneapolis Chamber, and the St. Paul Area Chamber to educate, inform, and respond to concerns related to the project. Local business groups such as the East Side Area Business Association and the Concord Street Business Association were mailed information on the project and informed of opportunities for public input.

Regulatory Meeting

A meeting was held gathering various regulators from the MPCA, DNR, U.S. Fish and Wildlife, and others to educate, inform, respond to concerns, and discuss regulatory issues related to the project. Twenty-seven regulatory agencies were invited. Most attended. Each agency was represented.

Environmental Groups

Personal contact was made with several environmental groups informing them of the project, including the Sierra Club, Izaak Walton League, Clean Water Action, Minnesota Environmental Advocacy and Earth Protectors. Metro area environmental groups were invited by fax and individual mailings to visit the Metro Plant to discuss the project and their concerns. More than 48 environmental groups received information on the solids project and were informed of opportunities for public input. This list also included Friends of the Mississippi River; Mississippi River Project; Citizens for a Better Environment; St. Paul Riverfront Corp.; and River Environmental Action Project in South St. Paul.

Neighborhood Informational Meeting

An informal neighborhood gathering provided an opportunity for neighbors and other interested individuals to learn about the solids processing project.

Neighborhood Town Meeting

MCES staff and a Council representative obtained feedback and comments from affected neighbors and other interested parties during a 90-minute session.

Communication Tools Utilized

The meetings were promoted in a variety of ways. Personal invitations describing the solids processing technology options were mailed to more than 100 interested individuals and organizations. These included community meeting participants, business groups, regulators and environmental groups, six local newspapers, Metro Plant neighbors, legislators, City Council Members, Ramsey County Commissioners, St. Paul Planning Commission, St. Paul Public Works, St. Paul Mayor's Office, District Councils 1, 3, 4, 7, and 17 and Westside Community Citizen's Organization. The Project mailing list was updated frequently.

Press releases and a personal invitation were sent to area media. Fliers were posted in the Daytons Bluff neighborhood and on the West Side at the Mounds Park Center, Conway Rec Center, Daytons Bluff library, Battle Creek Rec Center, and El Rio Vista Rec Center. Advertisements were placed in local newspapers.

At the beginning of February 1998, an informational packet was mailed to 240 interested individuals and organizations. This information provided an update on staff's recommendation, the technical memo and announced the date for the public hearing.

Internal Communications

Internal communication efforts continued throughout this time period. In January 1998, a workshop was held with the Council's Environment Committee to exchange information on the two technologies and alternative project delivery methods being considered and to define the criteria to be used to evaluate them. Information was provided and discussed with the Environment Committee on issues of major concern including odors, marketability of biosolids, mercury control, air emissions and specific technology economics.

In November, February, and March, "Metro Solids Project Update" was published and made available Council-wide. The project was featured in MCES's employee newsletter, Update. In addition, a "Solids Newsletter" with project updates was prepared and posted at the Metro Plant for plant employees.

Public Hearing, Workshops and Meetings with Concerned Citizens: April 1998-July 1998

While not required, the Council held a public hearing on the technology selection. All verbal and written comments were transcribed and distributed to all interested individuals. Testimony received at a workshop with the Environment Committee on April 28, 1998 was provided to interested individuals. Council staff provided a written response as well to all concerns raised during the hearing and workshop.

There were nine major areas in which testimony was given at the hearing or for which written comments were received before the public record closed on April 9, 1998: 1) Clean Air Act Emissions; 2) Mercury Control; 3) Greenhouse Gas Emissions; 4) Odor Control; 5) Sustainable Development; 6) Market and Economic Assumptions; 7) Energy Efficiency; 8) Environmental Review; and 9) Miscellaneous.

Comments regarding Clean Air Act emissions included concerns regarding metals and particulates that would be deposited in the river. Other concerns were raised regarding sulfur dioxide (SO_2), nitrogen oxides (NO_x), and carbon monoxide (CO) pollution from the incineration option when compared with other options.

Comments regarding mercury control indicated the need for mercury reduction and control equipment. Some felt that recycling lead, cadmium and mercury to the land is preferred. Others stated that heat drying would not volatilize mercury.

Comments regarding greenhouse gas emissions included concerns with complying with the Kyoto Protocol and evaluating other sources of greenhouse gases including methane and nitrous oxide.

Regarding odor control, support was expressed for incineration as the preferred technology since it has the least potential for odors.

Some comments on sustainable development questioned how the recommendation fits with the Council's position on sustainable development and what constitutes a reasonable price for sustainability. Others expressed the view that recycling of nutrients is preferred and land application equals sustainability by putting carbon, nitrogen and organics back in the soil.

Some felt that the market and economic assumptions used in the evaluation were biased. Others stated that farmers want pellets or N-Viro; there is a local market that represents a long-term opportunity. Farmers could save $20 per acre with heat-dried pellets.

Regarding energy efficiency, it was stated that co-generation was not adequately explored.

Some expressed the opinion that environmental review should include preparation of an Environmental Impact Statement (EIS). Others would like to see an Environmental Assessment Worksheet (EAW) completed for all options.

Some persons felt that the effort to inform the public of the hearing on incineration was inadequate; others are concerned with the stack height on the river; some pointed out that more jobs would be available with the heat drying technology.

Following the hearing and workshops, Council staff provided the opportunity for small meetings with interested citizens to exchange ideas and share additional information. At least five such meetings were held over a few weeks.

A response to all public comments, as noted above, was prepared and submitted to the Environment Committee and the Council. This document is available for public review, and is included in Appendix G.

The public also had an opportunity to comment about their concerns at various Environment Committee meetings, a workshop for the Council's Committee of the Whole (July 9, 1998) and on July 23, 1998, to the entire Metropolitan Council prior to its technology decision. Issues of public concern continued to be expressed, including the need to select a technology that guarantees odor reduction, the preference of certain citizens to consider heat drying or another land application alternative but not incineration, and the need for delay in the decision-making process while additional study is performed. Following consideration of all concerns, the Council adopted and directed staff to finalize a Facility Plan to include three fluidized bed incinerators and a land application process that would process up to 10 percent of the Metro Plant's total solids production. With this recommendation and in consideration of the public's input and concerns, the Council's action results in a diversification of technologies in the region, approximately 25 percent of all biosolids could be land applied and 75 percent of the region's biosolids could be incinerated.

Final Public Hearing

The Council held a public hearing on the draft Facility Plan on November 10, 1998. All verbal and written comments were transcribed and distributed to all interested individuals. Council staff also provided a written response to all concerns raised during the hearing. This document is included in Appendix H.

There were six major areas in which testimony was given at the hearing or for which written comments were received before the public record closed on November 23, 1998, including: 1) Sustainable Development; 2) Market and

Economic Assumptions; 3) Odor Control; 4) Riverfront Development; 5) Timing; and 6) Need for the Project.

Comments were received that the recommended alternative is not sustainable.

General comments were received regarding the value of biosolids as a fertilizer and the savings it creates for farmers.

Comments were received that neighbors to the plant have "put up with" the odors from the plant for years and the FBI alternative provided greater confidence that fewer odor sources would result in less odor problems in their neighborhood.

Comments were received that incinerators are not what citizens expect as part of riverfront development.

Comments were received that the project should move forward now to get on with the improvements that will eventually reduce odors to nearby residential areas. Comments were also received that the Council should not move forward with this facility plan because of the change in state administration.

Comments were received regarding whether the project is really necessary or can an upgrade of the existing system accomplish the same goals.

Continued Public Participation

MCES will continue to communicate with and provide updates to external and internal stakeholders about the progress of the Metro Solids Project. The public will have an opportunity to comment during the air permitting process. The public will be notified of the availability of the Facility Plan, and notice of public hearings will be given by the applicable agency. Efforts will continue to be made to assure that the public receives the information they request during the Project's development.

Section 11
Environmental Permits

Summary

A number of environmental permits and approvals must be obtained to authorize construction and operation of the new solids processing facility. The primary regulatory review processes are as follows:

- An air emissions permit major amendment must be issued by the Minnesota Pollution Control Agency (MPCA)
- A permit will need to be obtained form the USEPA to address the requirements of 40 CFR Part 503, subpart E, which are applicable to the fluid bed incinerators (FBIs)
- An Environmental Assessment Worksheet (EAW) is not required; however, MCES will prepare State Revolving Loan Fund Environmental Documentation
- Approvals and permits will need to be obtained for land application of the alkaline stabilized biosolids in accordance with 40 CFR Part 503, subpart B, and Minnesota Rules Chapter 7041

Additional permits and approvals that may be required are identified in this section.

Air Emission Permit Amendment

The MPCA will issue a major amendment to the Metro Plant's air emission operating permit as a result of the Solids Processing Improvement Project. A major amendment is required in accordance with Minnesota Rules 7007.1500, Subpart 1.C and D because the project is classified as a "synthetic" minor modification under the federal and state Prevention of Significant Deterioration and nonattainment New Source Review (PSD/NSR) regulations.

Air Emission Sources

The Solids Processing Improvement Project will yield significant reductions in actual air emissions compared with the current emission levels. The reductions result from the decommissioning of several emission sources, and from the application of state-of-the-art processing and pollution control technologies to the new equipment.

The following emission units will be decommissioned:

- Six multiple hearth incinerators
- Ash handling system

- Rotating biological surfaces (already decommissioned)
- Zimpro™ thermal solids conditioning

Decommissioning some of these sources will reduce the total amount of odorous air emissions from the facility. The rotating biological surfaces (RBS) and the RBS settling basins emit hydrogen sulfide and are some of the larger contributors of odorous emissions at the plant. Because of the low odor detection threshold of hydrogen sulfide, these sources can be relatively large contributors to odorous emissions while having relatively low mass emission rates. Actual hydrogen sulfide emissions are approximately 800 pounds per year from these two sources.

Although the Zimpro™ system is classified as an Insignificant Activity due to its low emissions of regulated air pollutants, its operation results in large amounts of odorous emissions elsewhere in the plant. A majority of these odorous emissions are likely hydrogen sulfide emissions.

New sources of air emissions associated with the Solids Processing Improvements Project include the following:

- Three FBIs
- Incinerator ash handling systems
- Alkaline stabilization material handling systems

Table 11-1 presents the regulated pollutants associated with each source.

TABLE 11-1
Emission Sources and Air Pollutants

	New Emission Sources			Existing Emission Sources to be Decommissioned			
Pollutant	Fluidized Bed Incinerators	Ash Handling Systems	Alkaline Stabilization	Multiple Hearth Incinerator	Ash Handling Systems	Zimpro™ Thermal Conditioning	Rotating Biological Surfaces
PM	●	●	●	●	●		
PM_{10}	●	●	●	●	●		
SO_2	●			●			
NOx	●			●			
VOC	●			●		●	
CO	●			●	●		
Lead	●	●	●	●	●		
H_2S			●			●	●
H_2SO_4	●			●			
HAP metals	●	●		●	●		
Volatile organic HAPs	●			●			
HCl	●			●			

● indicates pollutants of concern associated with each source.

Note: The project will result in a decrease in actual emissions due to the decommissioning of several emission sources and the application of state-of-the-art processing and control technologies to the new emission sources.

Applicable Air Emission Requirements

This section discusses the applicability of state and federal air emission regulations to the solids processing facility. The regulations are summarized as follows:

- The project will not be subject to review under the PSD/NSR regulations
- The FBIs are subject to current and anticipated New Source Performance Standards (NSPS)
- The project is subject to Part 61 National Emission Standards for Hazardous Air Pollutants (NESHAPs), Subpart E governing mercury emissions
- The FBIs will be subject to 40 CFR Part 503, subpart E
- The project is not subject to Part 63 NESHAP Maximum Achievable Control Technology (MACT) standards or case-by-case MACT determination under Section 112(g)

PSD/NSR Applicability

The decommissioning of the existing multiple hearth incinerators and the associated ash handling systems offers sufficient creditable reductions to enable the project to "net out" of PSD/NSR. Emissions netting is a term that refers to the process of considering previous and prospective changes at an existing facility to determine if a net emission increase of a pollutant will result from a proposed change at the facility. A proposed project is subject to PSD/NSR review only if the net emission increase for one or more pollutants were to exceed the respective de minimis threshold for that pollutant.

The application will specify emission limits for several of the regulated PSD/NSR pollutants that will qualify the project as a "synthetic" minor modification to an existing major source. The term "synthetic" is used to indicate that voluntary emission limits requested by MCES will be imposed in the permit to ensure that the net change in emissions is less than specified thresholds that would trigger PSD/NSR requirements.

The Metro Plant is an existing major source under the PSD/NSR rules. The plant is located within the Ramsey County nonattainment area for particulate matter with a diameter less than 10 micrometers (PM_{10}), and within the greater metropolitan carbon monoxide (CO) nonattainment area. The existing plant's potential to emit (PTE) for PM_{10} and CO is greater than 100 tons per year (tpy). The PTE for oxides of nitrogen (NO_X), sulfur dioxide (SO_2), and total particulate matter (PM) exceed the PSD major source threshold of 250 tpy. Any changes at the facility must be evaluated to determine the applicability of nonattainment NSR provisions for CO or PM_{10} as well as PSD rules for other regulated pollutants. The de minimis thresholds that would trigger PSD/NSR requirements are listed in Table 11-2.

TABLE 11-2
PSD/NSR Emission Thresholds

Pollutant	PSD/NSR Emission Increase Threshold (ton per year)
PM	25
PM_{10}	15
SO_2	40
NOx	40
VOC	40
CO	100
Lead	0.6
H_2SO_4	10.0
H_2S	10.0

Note: PSD/NSR review will not be required because the net change in emissions will not exceed the de minimis increase threshold for any regulated pollutant.

The potential emissions from the new solids processing facility would trigger review as a major modification to an existing major source under the nonattainment NSR requirements for PM_{10} and CO. Potential emissions of NO_X and SO_2 could exceed the PSD de minimis thresholds. However, the actual emissions from the new solids processing facility will be significantly less than the past actual emissions, making it possible to net out of PSD/NSR.

The Metropolitan Council is proposing voluntary limits on emissions of PM_{10}, PM, SO_2, VOC, H_2S, and lead. These limits will ensure that the difference between future potential emissions and past actual emissions for each pollutant less than the PSD/SNR de minimis threshold. The limits are lower than either the uncontrolled emission rates or the allowable emission rates prescribed by federal regulations and federally enforceable state rules. Control equipment is not required to keep emissions of other regulated pollutants below the maximum values that will qualify the project as a minor modification; therefore, it is not necessary to prescribe emission limits for the other pollutants.

Netting out of PSD/NSR offers benefits to the MPCA, MCES, the public, and the environment. The objectives of the PSD/NSR program (i.e., emission reductions, ambient air quality assessment, and mitigation of associated project impacts) will all be achieved sooner than if the permit application were to be processed under the PSD/NSR rules. These objectives are described as follows:

- A level of emission reduction equivalent to that which would be prescribed by the PSD/NSR rules will be achieved. The air pollution control systems being considered for use with the proposed equipment would qualify as Best Available Control Technology, satisfy Lowest Achievable Emission Rate criteria for nonattainment NSR, and satisfy future anticipated requirements.
- The reduction in PM_{10} emissions will help achieve and maintain compliance with the National Ambient Air Quality Standards (NAAQS) for particulate matter less than 10 micrometers in diameters (PM_{10}).
- Additional environmental impacts, which would normally be evaluated through the PSD review process, will be thoroughly assessed in State Revolving Loan Fund Environmental Documentation.

New Source Performance Standards

The federal New Source Performance Standards (NSPS), Subpart O, governs particulate emissions and visible emissions from sewage solids incinerators. These rules apply to sewage solids incinerators that charge more than 2,200 pounds of dry solids daily and that are constructed, reconstructed, or modified after June 11, 1973. PM is limited to 1.3 pounds per dry ton of solids charged. Visible emissions are limited to 20 percent opacity.

The existing multiple hearth incinerators are subject to NSPS Subpart O. The new FBIs are also subject to NSPS Subpart O.

National Emission Standards for Hazardous Air Pollutants

The new FBIs are subject to the NESHAPs for mercury specified in 40 CFR 61, Subpart E. This section discusses the applicability of the NESHAPs to the solids processing improvements project.

There are two sets of NESHAPS:

- 40 CFR 61 (Part 61) NESHAPs are risk-based standards, which were mandated by the 1970 clean Air Act Amendments. They apply only to a handful of pollutants emitted by specific categories of emission sources.
- 40 CFR 63 (Part 63) NESHAPs are technology-based standards; their development was mandated by the 1990 Clean Air Act Amendments. Part 63 standards are being promulgated in a phased approach between 1994 and 2000. Part 63 governs emissions of 188 listed hazardous air pollutants from several dozen emission source categories.

Part 61 Subpart C, Beryllium

The Part 61, Subpart C NESHAP for Beryllium will not apply to the new solids processing facility. It applies only to foundries, extraction plants, ceramic plants, propellant plants, and to incinerators that process wastes from these specific types of facilities. This determination is summarized in a USEPA memorandum dated July 16, 1979, from Edward E. Reich, Director, Division of Stationary Source Enforcement, to Stephen A. Dvorkin, Chief, General Enforcement Branch, USEPA Region II, (Control No. ZC12). None of these types of facilities are currently sewered to the Metro Plant.

This subpart formerly applied to the existing multiple hearth incinerators at the Metro Plant. A Bloomington foundry was engaged in casting beryllium-containing aerospace parts during the 1980s.

Part 61 Subpart E, Mercury

The Part 61, Subpart E NESHAP for mercury applies to the existing multiple hearth incinerators and will continue to apply to the new FBIs. This subpart limits facility-wide mercury emissions to 3,200 grams per day, which is equivalent to 1.29 tons per year.

During the past several years, the average mercury loading in the solids charged to the multiple hearth incinerators has been decreasing to the current level of less than 550 grams per day, resulting in annual emissions of only 0.1 tpy. The implementation of MCES's mercury reduction efforts should further decrease the solids mercury concentration. Continued implementation of these efforts is expected to result in lower emissions from the Metro Plant.

Part 63 NESHAP

Part 63 NESHAPs will not apply to the new solids processing facility because the Metro Plant is not a major HAP source. The Metropolitan Council requested, through the facility's Part 70 Operating Permit Application, that enforceable permit conditions be imposed to demonstrate the facility's status as a non-major source of hazardous air pollutants (HAPS). The application specifies limits on volatile organic HAPs, HAP metals, and HCl.

The development of Maximum Achievable Control Technology (MACT) standards was originally scheduled for two primary emission source categories present at the Metro Plant: publicly owned treatment works (POTWs) and sewage solids incineration. The USEPA has proposed regulating sewage solids incineration under Section 129 of the Clean Air Act instead of developing MACT standards under Section 112.

The application for the new Solids Processing Facility will specify new emission limits that will retain the Metro Plant's status as a non-major HAP source. Limits will be imposed on emissions from the FBIs and alkaline stabilization system. The limits will reapportion the potential HAP emissions that are presently allocated to the multiple hearth incinerators and the ash handling systems.

40 CFR Part 503, Subpart E

Regulations promulgated in accordance with the Clean Water Act and set out in 40 CFR Part 503, subpart E, require that daily concentration limits for seven metals found in sewage solids must be established for incinerators.

The daily emission limits for the FBIs will be determined using the following information:

- Emission control efficiency
- Dispersion coefficient of source emissions to maximum ambient air impact receptors
- Maximum allowable ambient air concentrations of the seven metals regulated under 503.43
- Daily sewage solids feed rates

Results form air emission dispersion modeling conducted by MCES will be used to establish the source-specific dispersion coefficients for each of the new sources. These coefficients, along with the information described above, will be input into the equations listed in 503.43 to calculate the emission limits for each source.

Sewage Solids Incinerator Rules Proposed for Development under Section 129

The FBIs would be subject to Section 129 standards if the USEPA were to advance rulemaking governing emissions from, and operation of, sewage solids incinerators. On January 14, 1997, the USEPA proposed to delist sewage solids incinerators from regulation under Section 112(d) of the Clean Air Act, and instead develop rules under Section 129. The rules would likely be patterned after rules already proposed or promulgated under Section 129 for municipal waste combustors and hospital waste incinerators. The regulated pollutants would include both criteria pollutants and several HAPs. These pollutants include:

- PM
- NO_X
- CO
- SO_2
- HCl
- Lead
- Cadmium
- Mercury
- Polychlorinated di-benzo dioxins and furans (PCDDs and PCDFs)
- Visible emissions

The air pollution control systems specified for the solids processing facility will meet, or can be upgraded to meet, any anticipated emission standards that may be developed under Section 129.

State Rules

Several state emission standards will apply to the proposed solids processing facility. The rules that apply for each of the alternative processing technologies are identified in this section. The voluntary limits requested for the modification to net out of PSD/NSR are generally more stringent than the limits specified by state rules.

The following rules apply to the FBIs and the associated equipment:

- Minnesota Rules 7011.1300—1350 set limits for PM emissions, opacity, minimum combustion temperature/retention time for sewage solids incinerators

- Minnesota Rules 7011.0700—0735 (Industrial Process Rule) sets limits on PM emissions from the ash handling and alkaline stabilization systems

Environmental Documentation

None of the mandatory EAW thresholds specified by Minnesota Rules 4410.4300 are triggered by this project. The change in emissions associated with this project is below the 100-ton-per-year threshold of any single pollutant after installation of air pollution control equipment (Subp. 15. A). It is anticipated that the gross floor space of the facility will fall below the 400,000-square-foot first-class-city threshold (Subp. 18.A.1). MCES will prepare State Revolving Loan Fund Environmental Documentation, which will compare the proposed project with existing conditions and determine if any significant impacts will result from the project.

Cultural Resources

The 106 Group and Anderson Environmental Services assessed the potential cultural significance of the selected site in the northeast corner of the plant. Archival research indicated that the Dakotan village of Kaposia and the Pigs Eye settlement might have been located in the area of the current Metro Plant. The northeast site was investigated to assess the potential for deeply buried archaeological sites to occur below fill material. Some of the trenches excavated for this investigation intercepted buried soil horizons, which had the potential to contain cultural materials. Given this potential of the soils and the importance of the two communities, further archaeological investigations were conducted at the northeast site. Further evaluations in the form of trenching were conducted and no cultural materials were encountered. Pending agreement from the State Historical Preservation Office (SHPO), no additional work is recommended for the site.

Land Application of Biosolids

Production, management, and application of alkaline stabilized biosolids will be governed by state and federal regulations. Federal regulations codified in 40 CFR Part 503,subpart B, and state regulations in Minnesota Rules Chapter 7041 apply to sewage solids destined for land application. These regulation specify:

- Criteria for classifying the sewage solids
- Risk-based limits on the concentration of toxic metals that can be present in the biosolids and limits on the amount of metal that can be land-applied
- Technology-based standard to minimize pathogens
- Technology-based standard to minimize vector attractions (i.e., characteristics that attract rodents, insects, or other organisms that can transport infectious agents)
- Monitoring, record-keeping, and reporting requirements

The applicable requirements from these regulations must be incorporated in the Metro Plant's National Pollutant Discharge Elimination System (NPDES) permit prior to any of the biosolids being land applied. Each land application site must also be evaluated and approved by the MPCA before biosolids can be applied.

Permits and Approvals

A complete list of permits that may be required as part of this project are included in Table 11-3.

TABLE 11-3
List of Potential Permits, Approvals, and Plans

Issuing Agency	Permit, Approval, or Plan
Federal Aviation Administration (FAA)	Notification of Proposed Construction or Alteration
U.S. Environmental Protection Agency (USEPA)	Permit to meet the requirements of 40 CFR Part 503, subpart E, for incineration of sewage solids
USEPA	Spill Prevention, Control, and Countermeasure (SPCC) Plan
Metropolitan Airport Commission (MAC)	Notification of Proposed Construction or Alteration (Coordinates with FAA)
Minnesota Pollution Control Agency (MPCA)	Plan and Specification approval
MPCA	Facility Plan approval
MPCA	Minnesota State Loan Funding approval
MPCA	Air Emissions Permit
MPCA	Modification of NPDES permit to meet the requirements of 40 CFR Part 503, subpart B (sludge management), and Minnesota Rules Chapter 7041
MPCA	Above ground tank registration for tanks over 110 gallons.
MPCA	Construction Stormwater Permit
MPCA	May need to revise current Hazardous Waste Contingency Plan
MPCA	May need to revise current Toxic Pollution Prevention Plan
Minnesota Emergency Response Commission and Local Fire Department	May need to revise SARA Title III Chemical Notification, Planning, and Reporting
Minnesota Department of Agriculture	May need to revise current Fertilizer License
Minnesota Department of Natural Resources	Coordination regarding bald eagles
Minnesota Department of Natural Resources	Water Appropriation Permit may be required for dewatering if more than 10,000 gpd or one million gpy is proposed
National Park Service (NPS)	Plan review and coordination under Mississippi National River and Recreation Area (MNRRA)
Ramsey County	May need to revise Hazardous Waste Generator License due to changes in waste generation
Ramsey-Washington County Watershed District	Grading Permit
State Historic Preservation Officer (SHPO)	National Historic Preservation Act Section 106 and the Archaeological Resources Protection Act Review and Coordination. Office of the State Archaeologist (OSA) coordinates with the SHPO
City of St. Paul	Plan review and coordination regarding St. Paul Critical Area planning
City of St. Paul	Building Permit

Section 12
Alternative Delivery Options

Overview

As part of the Solids Processing Improvement Project, a Task Force comprised of representatives from various MCES functional workgroups (e.g., Metro Plant Operations and Maintenance, Engineering, Construction, Contracts and Finance) was formed to:

- Identify applicable options for delivering a cost-competitive, technically sound Solids Processing Facility for the Metro Plant
- Evaluate the options identified and recommend the option that best meets stakeholders' (both internal and external) needs

This section summarizes the efforts of the Task Force and the approach taken to ultimately make a recommendation relative to delivery options.

Identification of Delivery Options

Several project delivery options were identified that have been (or are now being) used in the industry to deliver large municipal wastewater projects. This includes options for "complete delivery" of the project over its expected life (i.e., complete project implementation including design, construction and operation and maintenance), as opposed to simply getting the facility to the point of becoming operational. As a result, the following complete delivery options were identified.

Design/Bid/Build (DBB) Plus Operation and Maintenance

This is the traditional approach to delivering capital projects that MCES and most other municipal utilities around the country have historically used. It includes design (preparation of contract documents) by an engineering consultant or in-house design staff. Following design, construction bids are solicited and a construction contract is awarded to the lowest responsive, responsible bidder.

Following construction, the facilities are started up, operated, and maintained for their useful life using the owner's operations and maintenance (O&M) staff. However, due to changes in operational approaches occurring in the industry, several O&M approaches were considered.

MCES Staff O&M

The use of internal staff for operating and maintaining facilities has been the traditional approach used by MCES and other municipal utilities. All O&M staff are employed by the utility. In most cases, it has served the ratepayers well through a process of continuous improvements in delivery of O&M services.

Contract O&M

Some municipal utilities have recently been contracting with outside sources to provide O&M services in an attempt to take advantage of organizational efficiencies associated with the private sector. This approach entails soliciting O&M proposals from the private sector, generally for periods of 5 years or more. Recent changes to IRS regulations allow for longer contracting periods.

MCES Staff O&M through use of an "Internal Contract"

Using this approach, MCES O&M staff would identify various efficiency measures to be implemented and would develop an O&M budget for the facilities that they agree not to exceed. By doing so, the staff enters into an "Internal Contract" to not exceed that budget. A few municipal utilities around the country have recently used this approach to allow municipal employees to guarantee O&M to be as efficient as the private sector. Examples of various actions that can be (and have been) taken to improve O&M efficiencies include:

1. Implementing a streamlined, value-based procurement process that considers total "life-cycle" costs rather than low bid only.

2. Implementing an activity based accounting system to allow accurate tracking of actual costs and to identify potentially excessive cost centers. This provides O&M staff with the cost information they need on a day-to-day basis to allow them to effectively consider costs when making various O&M decisions.

3. Standardizing on the use of equipment and materials to allow staff to become more proficient and efficient in operating and maintaining a fewer number of types of equipment and to reduce the level of required spare parts that need to be inventoried.

4. Allowing staff to develop a "revenue enhancement" program where they offer services/capabilities to other agencies/organizations.

5. Automating plant operations to reduce O&M costs and to optimize operating efficiencies.

Design/Build (DB) Plus O&M

In an attempt to streamline project delivery and reduce costs, MCES and other municipal utilities around the country are beginning to evaluate the Design/Build (DB) approach to deliver capital projects. This approach includes preparation of preliminary engineering/design documents by an engineering consultant or in-house design staff. The extent to which the design is defined in those documents varies with the level of complexity of the project. If a project is relatively simple and straightforward, a limited amount of detail may suffice. However, as projects become more complex, additional detail must be provided to completely define the project. Typically, as a project becomes more complex, there are fewer advantages to using the DB approach. Following the preparation of the preliminary engineering/design documents, proposals are solicited from teams to complete the design and construct the facilities.

Following construction, the facilities are started up and operated and maintained using MCES staff, contracting with outside sources, or MCES staff through use of an "Internal Contract" (as described above for the DBB option).

Advantages of using the DB delivery option include the potential for streamlined delivery schedules and potential cost savings. Disadvantages include loss of control of the design and the perception of receiving a lower quality facility, since major design details are not defined.

Design/Build/O&M (DBO)

In an attempt to streamline project delivery and reduce costs, MCES and other municipal utilities around the country are beginning to evaluate this approach to deliver capital projects. This approach can include preparation of either performance standards or preliminary engineering/design documents by an engineering consultant or in-house design staff. Following preparation of the performance standards or preliminary engineering/design documents, proposals are solicited from private sector teams to complete the design, construct the facilities, start them up, and operate and maintain them for an initial period (usually a minimum of 3 to 5 years). The teams are usually comprised of a design firm, an operations firm, and a construction contractor.

Adding O&M to the DB approach ensures that the bidding team does not compromise the design of facilities since they would be responsible for keeping the facilities operational for an initial period of 3 to 5 years, and potentially longer through a series of contract extensions. Using this approach, the utility retains ownership of the facilities and can use tax exempt financing. In addition, they can either continue to contract out the O&M in the future or use their own staff.

Design/Build/Own/ O&M (DBOO)

This approach to delivering capital projects also attempts to streamline project delivery and reduce costs. Similar to DBO, it can include preparation of either performance standards or preliminary engineering/design documents by an engineering consultant or in-house design staff. Following preparation of the performance standards or preliminary engineering/design documents, proposals are solicited from teams to complete the design and construction of facilities; start them up; and own, operate, and maintain them for an extended period (usually up to 20 years). In addition, usually the private delivery teams secure the financing. Using this approach, the utility simply pays a fee to the private team based on the services provided. Following the contract period, the utility usually has the option of either extending the contract or taking ownership of the facilities, which includes operating and maintaining them with their own staff or having the services contracted out to another private vendor.

Evaluation of Delivery Options

The Alternative Delivery Task Force identified fourteen evaluation criteria for considering each project delivery option. The criteria identified are briefly described below:

1. **Costs**—Total costs associated with the project including initial capital and O&M costs over the life of the facility (life-cycle costs).

2. **Schedule**—Total time to deliver the project from the initiation of design through performance testing and start-up of all facilities.

3. **Risk of Performance Failure/Default**—Potential for a specific delivery approach to result in poor or unacceptable performance and ultimate failure.

4. **Risk of Unanticipated Financial Loss to MCES**—Potential for MCES to invest more in capital and/or O&M over the life of the facility than originally anticipated.

5. **Safety/Health Risks (to MCES staff and the public)**—Potential risks associated with either fewer health and safety issues being considered during design, construction and operations of the facility, or a lack of safety consciousness of key participants.

6. **Risks Associated with MCES's Ability to Deal with Changes**—Potential risks associated with addressing changes initiated by MCES during any phase of the project.

7. **Operational Control**—Potential impacts on other MCES facilities or processes due to MCES' inability to control operations at the new facility.

8. **Constructed Quality of the Facility**—Overall quality of equipment and materials and how they are incorporated into the facility that may impact long-term costs and ability to efficiently operate and maintain it.

9. **Innovation (in Selecting Technology)**—Perceptions associated with the ability to consider new ideas in an attempt to reduce costs versus incorporating too much conservatism (and the perceived cost associated with doing so) into the technology selection process.

10. **Project Flexibility**—The ability to deal with changes caused by external factors (such as needing to process more solids) throughout all phases of the project by making decisions quickly and having procedures in place to allow efficient response.

11. **Ability to Obtain Permits**—Ease of dealing with regulatory agencies in obtaining required permits for the facility associated with either their familiarity (or lack thereof) with the delivery approach and/or their history of dealing with project participants.

12. **HR Impacts (to MCES staff)**—Overall impacts to MCES staff associated with either changing the way they have historically provided services or loss of job opportunities.

13. **MCES Debt Capacity**—Potential impacts to MCES associated with their financing and ownership of the facility (by using a portion of their bonding capacity) versus being able to effectively "lease" the facility and use bonding capacity to fund other needs.

14. **Ability to Deal with Metro Plant and System-Wide Requirements**—Ease of interfacing with other Metro Plant treatment processes and/or other MCES facilities to meet potential changing needs of those processes or facilities.

The Task Force assigned points to each evaluation criteria for the alternative project delivery options identified. The results of this evaluation are included in the matrix table in Appendix I.

Outside Input

In addition to developing the evaluation criteria, the Task Force hosted a workshop where representatives of other large municipal agencies from around the country were asked to describe their efforts in delivering, or attempting to deliver, large municipal projects using some of the non-traditional delivery approaches being considered by MCES. The workshop was held on October 24, 1997, and participants included representatives from agencies in Boston, Massachusetts; New York, New York; Louisville, Kentucky; San Diego, California; and Seattle, Washington. A summary of that workshop is included in Appendix I.

During discussions with representatives from other agencies, several common themes appeared relative to when private ownership of facilities should be considered. They include:

- When an agency has no site of its own available for facilities
- When an agency has no prior experience with a specific treatment function or technology
- When an agency has an unusually short amount of time available to implement a project
- When an agency has a problem relative to being able to fund a project within its current bonding limits

None of the items listed above apply to the Metro Plant Solids Project. In addition, preliminary results from MCES's first attempt to compare the financial benefits of public ownership versus private ownership indicate that costs of public ownership are significantly less than costs of private ownership, due primarily to the much lower borrowing costs for public agencies such as MCES.

Conclusion

Upon review of both outside input and the internal evaluation, the Task Force concluded that the most advantageous delivery option for MCES on the Metro Plant Solids Project would be the traditional DBB approach integrated with use of the DB approach for delivering smaller design packages within the Solids Processing Improvement Project. This should be coupled with development of an "Internal Contract" for O&M by MCES staff.

However, MCES has recently committed to reducing staff agency-wide as it strives to continue to provide quality services at a competitive price. Therefore, the agency is already reducing the O&M costs and obtaining some of the advantages of an "Internal Contract".

A typical DB or DBO delivery approach is generally used for relatively straightforward, uncomplicated projects where project requirements can be described without an extensive amount of design effort. For more complex projects, the traditional DBB approach is warranted for the following reasons:

1. The Solids project is a major, complex facility that must be integrated into the existing Metro Plant processes without significant interruptions to normal operations. The Metro Plant has been upgraded and expanded numerous times and, as is typical at large facilities, it is likely that many of the modifications have not been well documented on Record Drawings. This can create major problems during construction unless a more complete design effort is performed to locate major pipes, utilities, and other obstructions. A DB proposer would include contingencies to protect against these unknowns or otherwise qualify its price proposal.

2. The Metro Plant is the heart of the MCES treatment system in that it processes more than 80 percent of the wastewater generated in the Twin Cities metropolitan area. MCES simply cannot afford to risk a plant shutdown that could be associated with construction problems encountered due to a lack of design detail provided.

3. DBB for this project will involve significant elements of DB in the procurement of the FBI and air pollution control system. Three parallel trains consisting of a fluid bed incinerator (FBI), heat exchanger, fluidizing air blower, waste heat boiler, dry electrostatic precipitator, heat exchanger, wet quench and scrubber in combination with a wet electrostatic precipitator, and induced draft fan have been approved as the preferred solids stabilization technology. These equipment trains will be required to meet specific performance requirements. Therefore, it is appropriate for equipment manufacturers to design, construct and initially supervise operation to prove compliance with the specified performance requirements (i.e. DB delivery). In defining requirements, the MCES will establish minimum equipment features, financial responsibilities, performance requirements, testing protocol and delivery schedules for coordination with other project elements. This DB procurement approach is required for early definition of system requirements to design structures and utilities to house and support the FBI and energy recovery process equipment. A DB delivery process for the Solids Management Building could not proceed until the FBI and air pollution control supplier had been selected and completed the initial design. This would significantly delay the building design and construction and ultimate delivery of an operable system.

4. As discussed above, MCES is continuing to reduce staff to provide cost-effective service to its ratepayers. To enable staff to efficiently operate and maintain new facilities in the future, MCES must allow its operations and maintenance staff to provide a significant amount of input into the design

and construction of those facilities. This will not only promote "buy-in" by staff to the efficiencies that must be incorporated into the facilities, but it will allow the agency to take advantage of the wealth of knowledge that exists among its staff relative to how the Solids project can and should be efficiently linked to the remainder of the Metro Plant facilities.

5. There is a need to accelerate implementation of portions of the project to effectively deal with the Notice of Violation relative to the emergency stack usage on the existing multiple hearth incinerators. It is possible that earlier delivery of some portions of the facilities might prevent the agency from spending a significant amount of money to resolve problems associated with facilities that will later be eliminated. These implementation details can be more thoroughly developed using a detailed design process.

6. MCES will pre-select some of the major components of the project that require long lead times for delivery. For example, the centrifuges will be selected based on the results of the on-going demonstration project. In addition, other components will require a significant amount of vendor involvement. For example, a single vendor should design, fabricate, and install the fluid bed incinerators (FBIs) and associated air pollution control systems. This extensive amount of "packaging" will require close coordination during design and construction of the entire project. The packaging of the FBIs and associated air pollution control components is a DB project within the overall project. It will be more efficient to allow the MCES DBB process manage this procurement rather than a DB contractor. The DBB engineer can begin design of the new Solids Management Building concurrently with initial design of the FBI and air pollution control equipment by the design-builder.

7. Because this is a large, complex project, it will be extremely important to incorporate an extensive amount of constructability knowledge into the design phase of the project to minimize construction change orders (and associated increased costs). MCES employs a cadre of well-qualified construction management staff who have been involved with numerous construction projects at the Metro plant. It will serve the agency well to capitalize on the wealth of knowledge that this staff has gained by allowing them to work closely with the design staff during the design phase of the project.

APPENDIX A
Recommended Alternative
Estimated Operations and Maintenance Costs

Category		Estimated Annual Cost[a]
Labor		$ 4,212,000
Electricity		3,211,000
Chemicals		2,353,000
Equipment Maintenance		2,493,000
Natural Gas		185,000
Alkaline Materials		331,000
Application of Biosolids		916,000
Ash Marketing		1,617,000
GROSS ANNUAL COST		**$ 15,318,000**
Less Energy Recovery Savings		
Electricity	(902,000)	
Heat Recovery	(378,000)	
Total Energy Recovery Savings		**(1,280,000)**
NET ANNUAL COST		**$ 14,038,000**

[a] Costs are in 2005 dollars.

Federal Aviation Administration
Great Lakes Region, AGL-520
2300 East Devon Avenue
Des Plaines, IL 60018

AERONAUTICAL STUDY
No: 97-AGL-5643-OE

Post-it™ brand fax transmittal memo 7671	# of pages ▸ 3
To Dave Raby	From Lori McIntyre
Co. CH2M Hill	Co. RCM
Dept.	Phone #
Fax # 6888844	Fax #

RESEND

ISSUED DATE: 09/14/98

ALLEN DYE
METROPOLITAN COUNCIL ENV. SVCS
230 E. FIFTH ST. (MEARS PARK CTR)
ST. PAUL, MN 55101-1633

** DETERMINATION OF NO HAZARD TO AIR NAVIGATION **

The Federal Aviation Administration has completed an aeronautical study under the provisions of 49 U.S.C., Section 44718 and, if applicable, Title 14 of the Code of Federal Regulations, part 77, concerning:

Description: 2 BUILDING 90'+ 70' HIGH + STACK 130'

Location:	ST. PAUL, MN
Latitude:	44-55-46.39 NAD 83
Longitude:	093-02-30.10
Heights:	105 feet above ground level (AGL) 805 feet above mean sea level (AMSL)

This aeronautical study revealed that the structure would have no substantial adverse effect on the safe and efficient utilization of the navigable airspace by aircraft or on the operation of air navigation facilities. Therefore, pursuant to the authority delegated to me, it is hereby determined that the structure would not be a hazard to air navigation provided the following condition(s), if any, is(are) met:

-It is required that the enclosed FAA Form 7460-2, Notice of Actual Construction or Alteration, be completed and returned to this office any time the project is abandoned or:

/ At least 10 days prior to start of construction (7460-2, Part I)

/ Within 5 days after construction reaches its greatest height (7460-2, Part II)

Marking and lighting are not necessary for aviation safety.

This determination expires on 04/24/00 unless:

(a) extended, revised or terminated by the issuing office or
(b) the construction is subject to the licensing authority of the Federal Communications Commission (FCC) and an application for a construction permit has been filed, as required by the FCC, within 6 months of the date of this determination. In such case the determination expires on the date prescribed by the FCC for completion of construction or on the date the FCC denies the application.

NOTE: REQUEST FOR EXTENSION OF THE EFFECTIVE PERIOD OF THIS DETERMINATION MUST BE POSTMARKED OR DELIVERED TO THIS OFFICE AT LEAST 15 DAYS PRIOR TO THE EXPIRATION DATE.

-As a result of this structure being critical to flight safety, it is required that the FAA be kept apprised as to the status of this project. Failure to respond to periodic FAA inquiries could invalidate this determination.

Appendix B

petition on or before 10/14/98. In the event a petition for review is filed, it must contain a full statement of the basis upon which it is made and be submitted in triplicate to the Manager, Airspace and Rules Division ATA-400 Federal Aviation Administration, Washington, D.C. 20591.

This determination becomes final on 10/24/98 unless a petition is timely filed. In which case, this determination will not become final pending disposition of the petition. Interested parties will be notified of the grant of any review.

This determination is based, in part, on the foregoing description which includes specific coordinates, heights, frequency(ies) and power. Any changes in coordinates, heights, frequency(ies) or use of greater power will void this determination. Any future construction or alteration, including increase in heights, power, or the addition of other transmitters, requires separate notice to the FAA.

This determination does include temporary construction equipment such as cranes, derricks, etc., which may be used during actual construction of the structure. However, this equipment shall not exceed the overall heights as indicated above. Equipment which has a height greater than the studied structure requires separate notice to the FAA.

This determination concerns the effect of this structure on the safe and efficient use of navigable airspace by aircraft and does not relieve the sponsor of compliance responsibilities relating to any law, ordinance, or regulation of any Federal, State, or local government body.

This aeronautical study considered and analyzed the impact on existing and proposed arrival, departure, and en route procedures for aircraft operating under both visual flight rules and instrument flight rules; the impact on all existing and planned public-use airports, military airports and aeronautical facilities; and the cumulative impact resulting from the studied structure when combined with the impact of other existing or proposed structures. The study disclosed that the described structure would have no substantial adverse effect to air navigation.

An account of the study findings, aeronautical objections received by the FAA during the study (if any), and the basis for the FAA's decision in this matter can be found on the following page(s).

A copy of this determination will be forwarded to the Federal Communications Commission if the structure is subject to their licensing authority.

If we can be of further assistance, please contact our office at 847-294-7569. On any future correspondence concerning this matter, please refer to Aeronautical Study Number 97-AGL-5643-OE.

Zaunahu M Bays

Michelle M. Behm
Manager, Airspace Branch

(DNH)

7460-2 Attached
Attachment

The proposed structure would be located approximately .83 nautical miles east, southeast of the St. Paul Downtown-Holman Airport, St. Paul, Minnesota. It would exceed the obstruction standards of the Federal Aviation Regulations, Part 77 as follows:

> <u>Section 77.23(a)(3)</u> by <u>25</u> ft. – a height that increases a minimum instrument flight altitude within a terminal area (TERPS criteria)
>
> The proposal would create a departure procedure requiring a take off climb of 260 feet per nautical mile to 1400 feet. as applied to St. Paul Downtown-Holman Airport, St. Paul, Minnesota.
>
> <u>Section 77.25(e)</u> by <u>13</u> ft. – A height exceeding a transition surface as applied to St. Paul downtown Holman Airport.

The proposal was circularized for public comment by letter dated August 4, 1998. Subsequent to circularization and through negotiations with the FAA, the Proponent in the intere. of aviation safety, refined the height of the proposal to 105"GL/805"MSL. This reduction of heights eliminated the adverse effect the original proposal would have had c· FAA obstruction standards and operations at St. Paul Downtown-Holman Airport, St. Paul Minnesota.

At the revised height, the proposed construction would not exceed the obstruction standards of the Federal Aviation Regulations, Part 77. Therefore, this aeronautical study is terminated.

Evaluation of RHOX Alternative Technology

PREPARED FOR:	John Spencer
PREPARED BY:	Peter Burrowes
COPIES:	Kim Erickson Allen Dye, Project Manager
DATE:	December 23, 1997
SUBJECT:	MCES – Metro Solids Improvement Project
PROJECT NO.:	MCES 970300 CH2M HILL 142333.FP.10.02

INTRODUCTION

The Metropolitan Council Environmental Services (MCES) recently completed a comprehensive Master Plan (MP) for the Metropolitan Waste Water Treatment Plant (Metro Plant) in St. Paul, Minnesota. A major component of the MP was to examine and recommend improvements to the solids handling and disposal system. The preferred alternative from the MP recommends installation of new solids processing equipment and construction of a new solids building to house the equipment. The thermal conditioning (Zimpro) system will be retired and raw sludge will be dewatered by centrifuges, prior to incineration. The preferred alternative consists of 3 fluidized bed incinerators (FBI), 3 pug mill mixers for alkaline stabilization, and 8 high torque centrifuges for dewatering. The FBIs are intended to handle annual average solids from the plant. The alkaline stabilization is intended to handle peak solids, as well as solids when the FBIs are out of service. Currently, there is a centrifuge demonstration project underway at the Metro Plant.

The present solids processing operation at the Metro Plant consists of gravity thickening of primary solids and flotation thickening of waste activated solids. The thickened waste activated sludge is thermally conditioned, and either dewatered on vacuum filters and incinerated or mixed with thickened primary sludge, dewatered on roll presses and incinerated.

The thermal conditioning system will be retired, as part of the Solids Processing Improvements Project and primary and waste activated sludge will be mixed and dewatered, prior to final disposal.

The MP did not include alternatives that would retrofit the existing multiple-hearth furnaces (MHF) to handle wetter dewatered sludge solids and the employment of innovative and cost effective retrofit air pollution control technology that would meet or exceed the stringent EPA requirements. The MP determined that the existing equipment would reach the end of its useful life by the year 2005 and the alternatives evaluated were based on new pollution control equipment. The MCES received a proposal from RHOX Technologies Inc., to provide a RHOX-MHF process as a retrofit for the existing MHFs. The purpose of this memo is to evaluate the RHOX process and to provide a comparison analysis of the MP alternative to the RHOX process.

The information presented by RHOX is incomplete. RHOX was requested to provide additional cost information to allow a comparative monetary evaluation. RHOX was also requested to address some

Appendix C

non monetary issues. RHOX indicated that they did not have the resources to provide all of the requested information and have not pursued this alternative further. The evaluation is based on information provided by RHOX. The information gaps have not been filled.

RHOX TECHNOLOGY DESCRIPTION

The RHOX Process evolved out of a dual need to retain the proven advantages of the MHF to dry and combust wet sludge cakes at low fuel cost while concurrently producing high quality stack emissions. These two needs were not satisfied with the MHF employing a direct high temperature afterburner due to the excessive fuel costs. However, after the MHF gases have been cooled and scrubbed nearly free of particulates and condensibles at about 100 °F, the waste gases can be processed through a secondary combustor at temperatures of 1600-1700 °F to remove the CO, THC, dioxins and other trace organic vapors. The secondary combustor is a high efficiency regenerative afterburner (thermal oxidizer) which can recover/reuse 92-95% of the heat input.

The regenerative (or recuperative) thermal oxidizer (RTO) has been employed for many years in industrial applications to oxidize organic fumes and vapors. The unit can handle large volumes of gases -- largest would handle the equivalent off-gases from 20 of the largest MHFs. These units typically operate at 1500 to 1800 °F, but can operate up to 2300 °F for temperature refractory organics.

Since the thermal oxidizers operate best on particulate free gas streams and the advantages of the wet electrostatic precipitator (WESP) in removing fumes (including heavy metals) are well proven, the WESP is a natural addition to the RHOX system.

The MHF-RHOX system (Figure 1) consists of the MHF operating in a primary combustion mode at the maximum drying-combustion capacity with minimal regard to the stack gas quality. Typically the exhaust temperatures will be 800 to 1000 °F where nearly self-sustaining combustion for 24-27 % TS sludge cake can be maintained. The gases are wet scrubbed by conventional venturi collectors and tray cooler-washers to about 100 °F and a particulate-condensable content of 50 - 80 % of current EPA requirements. The cooled gases after being processed through the WESP will undergo a further 60-90 % reduction in the particulates and heavy metals prior to the thermal oxidizer. In the regenerative oxidizer, the treated gases preheat the cool incoming gases, recovering 90-95 % of the heat and a small amount of fuel is used to raise the gases to the final temperature of 1600 - 1700 °F. Unlike conventional MHF afterburners, there is only a minor increase in fuel required to operate at 1800 °F vs. 1500 °F in the thermal oxidizers due to the high heat recovery. There are six operating MHF-RHOX installations and one under design in North America.

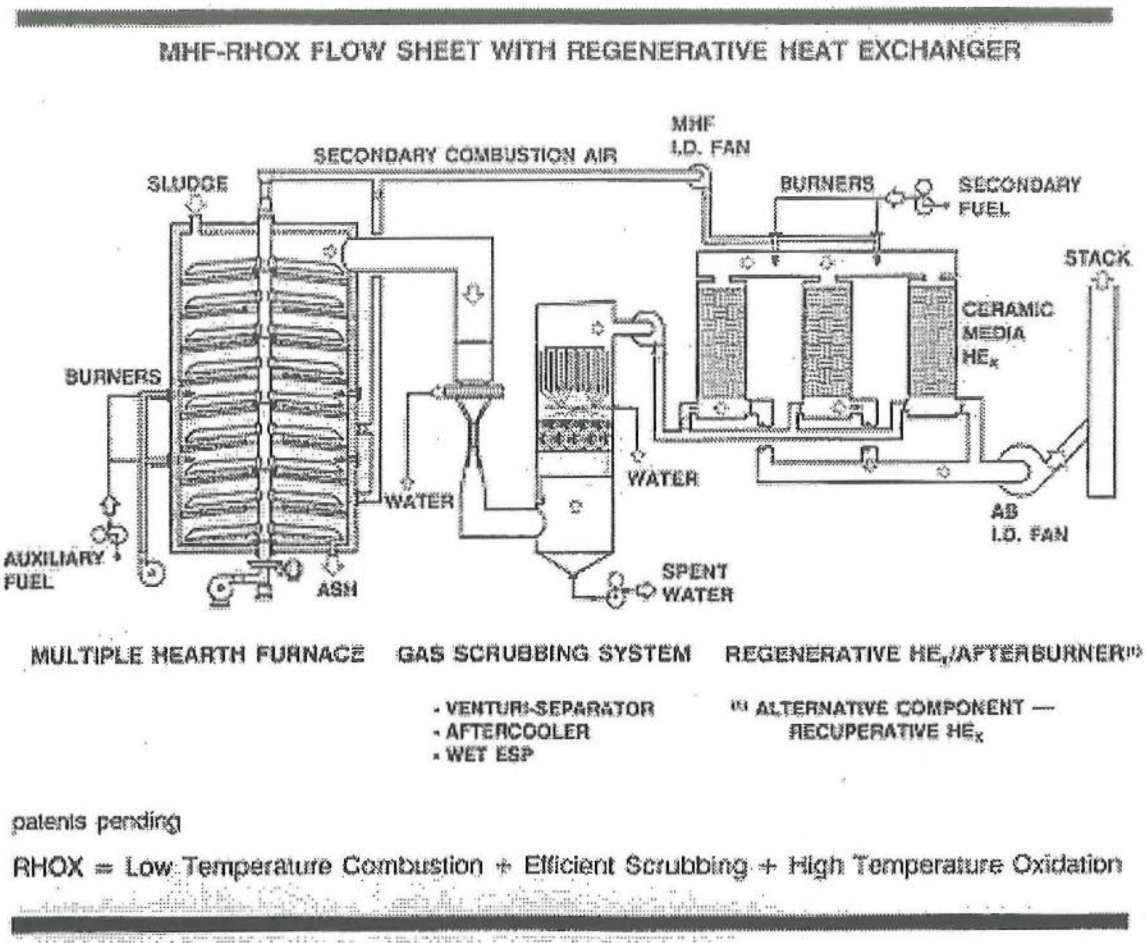


Figure 1. MHF-RHOX System

The RHOX process has demonstrated the capability to achieve and exceed the thermal oxidizing capacity of a fluid bed reactor (THC, dioxin/furans). At Hatfield MA, the MHF-RHOX process reduced total dioxin/furans to 2 pg/m^3 or 1.8% of the 125 ng/dscfm, the MACT limit for MSW incinerator facilities > 35 Mg/d capacity. The MHF-RHOX has the capability to provide similar particulate matter and heavy metal emissions to the FBI systems. The MHF-RHOX process cannot achieve the low NOx emissions of the FBI. NOx emissions, however, are lower than a comparable MHF with conventional afterburning.

Capacity Considerations

The MWWTP must have a solids management capacity to handle an annual average 285 dry tons of dewatered cake for the year 2040, as well as a peak week capacity of 376 dry tons per day. RHOX estimates that each RHOX-MHF will have a capacity to incinerate 64 dry tons per day. With 6 units installed and 1 out of operation, the firm capacity of the system is 320 Dt/d. This is adequate for the annual average sludge production. An additional 56 Dt/d of firm capacity is necessary to meet the peak week capacity. This can be provided by installing 2 alkaline stabilization systems, each with a capacity of at least 64 Dt/d.

Modifications and Implementation

A number of modifications and additions are required to both the existing dewatering and MHF systems to accommodate the RHOX-MHF process. The MP indicated that the existing MHF system would reach the end of its useful life around 2005. Thus, major equipment replacement will be necessary to prolong the life of the existing equipment. Additions include facilities to accommodate new WESPs, new RTOs and new alkaline stabilization trains, as well as storage for the alkaline stabilization system.

The thermal conditioning system will be retired. The raw waste activated sludge, together with the raw primary sludge will be dewatered by new high torque centrifuges. The new centrifuges will be installed in the existing dewatering building. This will require removal of some of the existing dewatering units. The existing belt conveying system will be replaced to accommodate the new centrifuges, as well as to provide efficient conveying of the centrifuged cake. These modifications will require careful planning and implementation to avoid disruption of the existing operations.

The current configuration of the MHF was a modification (removal of 2 hearths) to provide increased combustion space for the burning of the drier heat treated sludge in one zone as well as increasing the afterburning volume available at the top of the furnace to improve stack gas quality. In the RHOX mode these hearths would be replaced to accommodate the raw sludge and the drying-combustion-carbon burn off area would increase 22%. That is, the MHF would be returned to the original and more efficient design employed for wetter untreated sludges. The incinerator refractory material will be replaced completely, as part of these modifications. The incinerator shells will be repaired where thinning due to corrosion has occurred.

Scrubbers and ID fans will be replaced with larger units to accommodate the increased gas flow rates, due to the re-rating. Ductwork and refractory will be repaired or replaced as necessary. The emergency bypass dampers will be replaced with tighter emergency bypass dampers to reduce the leakage during normal operations. ***Note, this will not eliminate the permit issue regarding combined particulate matter emissions from the MHFs and the emergency bypass stacks under all conditions. EPA has indicated that permit compliance is based on particulate emissions from the total exhaust gas flow from the incinerators and emergency bypass stacks.***

The new equipment will be housed in building additions to the existing incinerator complex. This will require long runs of ductwork and new stacks.

The MHF-RHOX Process at Metro WWTP

There are a number of potential advantages to the employment of the RHOX Process at the Metro facility. These are:

1. Implementation. Experiences from other facilities have demonstrated that the RHOX process can be in place 18 to 30 months after the start of engineering. This assumes that no additional permitting is required. The extensive modifications and additions will require re-permitting.
2. Ongoing Operation. The WESP and regenerative afterburner can be constructed and ready for tie-in without disrupting the MHF operations. Modifications to the dewatering and MHF systems will require equipment out of service during construction. This will add additional complexity and cost to the system during construction.
3. Scheduling Aspects. The high quality stack gases may be achieved in the year 2001.
4. Permits. The existing MHFs are permitted and this could avoid a lengthy and unpredictable quest for new permits for FBIs. This may be off-set as discussed in 1. above.
5. Metro Experience. The operating and maintenance staffs are knowledgeable regarding the existing MHF operations, maintenance and training would be minimal.

6. Staffing. The staff requirements for a MHF-RHOX combustion facility would be about the same as that needed for the existing MHF system. Additional staff may be needed for the alkaline stabilization operation.
7. Capacity. The 6-MHF would provide a higher firm capacity than 3-FBIs and can process a wetter sludge more effectively.

EVALUATION

In accordance with the format of the MP, the MHF-RHOX system will be compared to the existing and the MP preferred alternative. Both costs and non monetary factors are considered.

Costs

The RHOX proposal presented estimated capital costs to upgrade the MHF system of $93.6m. This cost estimate did not include costs for any buildings for the equipment additions, nor did it include costs for: upgrading the sludge conveying system, new electrical and instrumentation equipment, and new HVAC equipment. Costs included for MHF upgrading/rehabilitation appear to be low, when the upgrades include replacing the existing APC equipment, upgrading the emergency bypass dampers, and all the equipment associated with dewatering and inicneration. The RHOX proposal estimates about $50m savings over the MP preferred alternative. The addition of costs to cover the items not included in the RHOX proposal will provide a better comparison with the MP preferred alternative. The MHF-RHOX system will not provide a new system. Any potential savings from RHOX, therefore, will not compensate for a new system.

The RHOX proposal provides a comparison of operating costs with MP Alternative S10. The MP preferred alternative was a variation of Alternative S10 and the operating costs are less than Alternative S10. Some of the basic assumptions used by RHOX are incorrect. These include workforce estimates, fuel requirements, ash reuse and land application. The comparison, as presented by RHOX favors the MHF-RHOX system. Using the rationale developed for the MP, Alternative S10 has lower operating costs than the MHF-RHOX system. Operating costs for the MP preferred Alternative S6b are even lower.

Non monetary Factors

The following non monetary factors were identified with the MHF-RHOX alternative:

- Staffing Impacts: This alternative would not be disruptive to staff as it consists of operating several of the existing unit processes. Training would be required for the new WESPs, RTOs and centrifuges. There may be an increase in the amount of work with the installation of new equipment. When compared with the MP preferred alternative, the long-term operation of the fluid bed incinerators will be easier and there is a projected reduction in work with the MP preferred alternative.
- Resource Requirements: An increase in natural gas would result from the installation of MHF-RHOX, due to the change in sludge quality. Without the waste heat boilers, gas use for plant heat would increase. When compared with the MP preferred alternative, there will be an increase in natural gas.
- Space Impacts: Additional space would be required for the additions to the existing incinerator building, but space would become available with demolition of thermal conditioning, return liquor treatment facilities and the decant tanks. When compared with the MP preferred alternative, MHF-RHOX alternative would require less space.

- Environmental Impacts: Installation of MHF-RHOX alternative would reduce air emissions over the existing system, except for the emergency bypass particulate emissions. Eliminating thermal conditioning would reduce odorous emissions. When compared with the MP preferred alternative, fluid bed incinerators would reduce emissions more than the MHF-RHOX system.
- Residuals: Ash production would be the same for both the MHF-RHOX and the MP preferred alternative.
- Flexibility: The MHF-RHOX alternative would not improve flexibility as space for expansion of the secondary system would not become available. The MP preferred alternative has more flexibility.
- Reliability: The processes and equipment are proven and would be reliable. However, the ability to meet the permit requirements is questionable, due to the emergency bypass particulate emissions. When compared to the MP preferred alternative, MHF-RHOX has a lower reliability.
- Operability: The MHF-RHOX process and equipment are not complex and would not impact operability. When compared to the MP preferred alternative, initially the fluid incinerators would be more complex to operate. Once staff is familiar with the equipment, less work is anticipated than with the MHF-RHOX operations.
- Maintainability: Maintenance would not be a significant concern. The MP preferred alternative would require less maintenance than MHF-RHOX and there would be better conditions for maintenance with the FBIs.
- Safety Impacts: This alternative would not significantly impact safety.
- Implementation: Implementation of MHF-RHOX would depend on whether permitting is required. There is not expected to be an impact on the workforce, due to the increase in work. When compared to the MP preferred alternative, implementation would depend on permitting the new fluid bed incinerators. Normal operations could be impacted during construction of the retrofits. The significant impact on the workforce would offer potential for conflict with bargaining units.

SUMMARY

Conclusions

The main conclusions of the evaluation are as follows:

- The MHF-RHOX alternative has the potential to reduce initial construction costs over the MP preferred alternative. Operation costs are expected to be higher than the MP preferred alternative. Life cycle costs may be higher due to the age of the existing systems and the need for more frequent upgrades, maintenance and for more replacements. However, due to insufficient information, this cannot be confirmed.
- The comparison of non monetary factors between the existing system and the MHF-RHOX alternative indicates a number of advantages and improvements with the MHF-RHOX alternative. When compared to the MP preferred alternative, the MHF-RHOX indicates a number of disadvantages.
- The most significant disadvantage is the emergency bypass particulate issue. Prolonging the life of the MHFs will extend the problem of uncontrolled particulate emissions from the emergency bypass stack, risking permit violations and action by EPA.
- The MHF-RHOX alternative, while utilizing and extending the life of the existing equipment, does not provide the long term reliability required by the MP. The MHF-RHOX alternative may not give as long equivalent life as the FBIs.

Recommendations

Based on the conclusions of the evaluation, it is recommended that the MHF-RHOX alternative not be evaluated further.

Market Study
Managing Ash from Biosolids Incineration

Prepared for Metropolitan Council Environmental Services
by Richardson, Richter & Associates, Inc. and
Environmental Financial Group

December 30, 1997

Appendix D

Table of Contents

TABLES

Executive Summary

The Metropolitan Council Environmental Services (MCES) operates the Metropolitan Wastewater Treatment Plant (Metro Plant) located on the Mississippi River near Pigs Eye Lake in St. Paul. At present, biosolids (sewage sludge) from this plant are incinerated using multiple hearth technology, and the ash from this process is being utilized in construction materials.

As an outcome of a planning process which identified the need to replace out-dated solids handling equipment at the Metro Plant, the MCES has initiated a capital project to replace current solids handling systems. The two stabilization technologies being evaluated are heat drying for pelletization, and fluidized bed incineration. As a part of the evaluation, the market for residuals are being assessed, including markets for a dried biosolids products which could be land applied, and markets for ash utilization. This study reviews ash utilization practices around the country and assesses the potential local market.

Research of beneficial use of ash around the country shows that the Metro Plant is one of the few to succeed in utilizing 100% of their ash. Other successful programs include those in Virginia and California, where ash is utilized as a construction material and a soil supplement, respectively. Interest in beneficial use of ash is expected to grow in other parts of the country as landfill capacity diminishes and an environmental ethic for the use of residual waste becomes more pervasive. Several sewage districts in the Midwest have begun work on identifying ash utilization opportunities.

The markets for sewage sludge ash from the Metro Plant appear to be promising in the coming years due to the number of different uses for ash, and the size of each of the various market segments. Still, marketing potential has not been fully realized yet, and some significant barriers to successful market expansion exist. Among the most significant barriers are acceptance by end-users of a waste material, and concerns about long-term environmental liability.

The future cost to beneficially use ash from the Metro Plant will be related to the development of commercially viable and sizable local markets. As local markets continue to grow, the cost to the MCES for ash utilization may decrease due to increased demand for ash and lower transportation costs. Of the possible local markets, cement manufacturers, mining companies, and roadway materials manufacturers appear to be the most promising. A significant market for MCES ash which has not yet materialized is the Minnesota Department of Transportation (Mn/DOT) which develops specifications for road construction in Minnesota; Mn/DOT and the cities and counties which use their specifications for procurement could be major end-users.

With regard to long-term price stability, the number of markets available means that the failure of any single market is not likely to effect the overall cost. In addition, market failure is less of a concern since landfilling options may be readily available as a back up to utilization.

I. Background

The Metropolitan Council Environmental Services (MCES) operates the Metropolitan Wastewater Treatment Plant (Metro Plant) located on the Mississippi River near Pigs Eye Lake in St. Paul. At present, sewage sludge from this plant is incinerated using multiple hearth technology, and the ash from this process is being utilized in construction materials.

As an outcome of a planning process which identified the need to replace out-dated solids handling equipment at the Metro Plant, the MCES has initiated a capital project to replace current solids handling systems. The two stabilization technologies being evaluated are heat drying for pelletization, and fluidized bed incineration. As a part of the evaluation, the market for residuals are being assessed, including markets for a dried biosolids products which could be land applied, and markets for ash utilization.

This market study provides the MCES with a current assessment of ash marketing practices and trends around the country, and also provides the basis for a projection of the future cost to continue to beneficially use ash in accordance with Council policy.

A. Characteristics of Sewage Ash

A report was submitted to the Legislative Commission on Waste Management in October of 1990 regarding sewage sludge ash use in bituminous paving. This report characterized MCES's incinerator ash as a non-hazardous material which looks like fine sandy soil. A request for proposals issued by the Metropolitan Waste Control Commission (MWCC) in February 1989 stated that the bulk density of ash is 30 to 60 pounds per cubic foot and that ash has a specific gravity of 2.6 to 2.8. Detailed descriptions of ash characteristics, and results of ash testing are included in the "Sewage Sludge Ash Use in Bituminous Paving Report to the Legislative Commission on Waste Management", October 1990. Periodic testing of ash since that time has confirmed its non-hazardous nature.

B. History of Metro Plant Ash Management

In 1980 the MWCC adopted a plan to develop a new sludge ash landfill. Interest in ash utilization was prompted by considerable community opposition during the ash landfill site selection process. In addition, MWCC had begun to discuss ash utilization opportunities with Consolidated Management Corporation (CMC) which was interested in reclaiming precious metals from the ash. In January, 1986, MWCC issued a request for proposals to remove and recycle ash from the storage basins. They received 14 proposals and selected CMC to transport the ash to Edgemont, South Dakota where the company was to extract precious metals from the material. The residual ash was to be recycled through various means including conversion to a lightweight aggregate. CMC failed to raise funds to build their plant, and in March of 1988, the MWCC terminated the contract with CMC. Ash that had been sent to the facility site was ultimately landfilled at the Edgemont site.

In January, 1989, the MWCC passed a resolution adopting an ash management plan with the following goals:

> *"to utilize or dispose ash in a manner that is environmentally sound, publicly acceptable, politically possible, economically viable, and reliable."*

The MWCC issued another RFP and, in March 1989, they received another 14 responses including the following:

Herzog St. Joseph, Missouri	Ash use in concrete products
L&G Rehbein Company Hugo, Minnesota	Land spreading of ash
Blue Ridge Gold Corporation Tolston, Montana	Recovery of precious metals from ash
SA-AG Minnesota	Land reclamation of a gravel/sand pit in Apple Valley, Minnesota
Municipal Services Corporation	Aggregate production from ash
Nalco	Metals removal
Mn/DOT	Ash-asphalt demonstration projects
University of Minnesota	Light-weight aggregate production

In December, 1989, the MWCC's Board of Commissioners approved contracts with Herzog Waste Management, Inc. and L&G Rehbein Company. The Herzog contract includes a guarantee of 15,000 tons per year of silo ash from the Metro Plant. The Rehbein contract does not include a minimum guarantee.

Through these two contracts, the MWCC (now MCES) has fully achieved the goal of recycling all current ash production. In addition, MCES succeeded in recycling 160,000 tons of ash previously stored in basins near the Metro Plant and the Seneca Plant.

As part of the effort to ensure strong long-term markets for ash, the MWCC, in conjunction with the MPCA and Mn/DOT conducted demonstration projects in 1989 and 1990 to use ash in bituminous paving. A report to the Minnesota Legislature on the results of these demonstration projects indicated that using ash in bituminous paving is "practical, economical, and environmentally sound". While no problems were detected through physical and environmental testing, and potential benefits such as improved pavement strength and reduced asphalt use were found, concern about potential long-term liability was identified as a barrier to the full-scale use of ash by Mn/DOT.

C. Regulatory Background

Ash in Road and Building Materials

The beneficial use of ash by MCES is a separately permitted activity under statute and solid waste rules. On November 5, 1985, the Minnesota Pollution Control Agency (MPCA) issued a permit (SW-292) for operation of an Ash Utilization Program. At the time of the permit, no public comment was received. The permit initially allowed for the use of ash as an admixture in the manufacturing of asphalt. The Permit also allows for additional utilization options to be considered but only if the permittee requests in writing and receives the approval of the Director of the MPCA.

In August 1990, the MPCA granted utilization of a cement/ash/water composite pursuant to certain conditions. The cement/ash/water composite could be mixed in ratios dependent on the specific end use of the material. The MPCA recognized the following end uses:

- general purpose cement,
- ready-mix concrete,
- structural fill,
- paving subbase,
- building backfill,
- flowable fill and pipe bedding for underground utilities and other structures.

In addition to these changes in permitted uses, the 1989 Waste Management Act Amendments authorized a study of Sewage Sludge Ash Use in Bituminous Paving as a joint project of the MPCA, Mn/DOT and MCES. (Minn. Stat. Chap. 325 Section 72). Subdivision 3 of this statute provided an indemnification by the State to the parties through the State's general fund for all liability related to sewage sludge ash demonstration projects. Prior to the use of the sludge ash in any asphalt, composite ash sampling was required to assure the ash complied with the permit (SW-292) and MPCA rules. Environmental testing over a period of years was recommended.

Ash/lime Sludge Land Application

In Minnesota, land applying of ash is prohibited without special permits. A separate use of ash under Permit SW-292 for ash/lime sludge application was approved by the MPCA in March 1990. The MPCA found that such application would provide a soil amendment to neutralize acidic soils. Use of the ash in this application was subject to certain conditions. MCES must submit a land-spreading application for *each individual site* where ash/lime sludge is to be applied. MPCA does an inspection and MCES must also show proof of local government notification for use on each site.

II. Regulatory Issues

The following states were contacted regarding regulatory issues related to biosolids ash use: Illinois, Iowa, Michigan, Minnesota, and Missouri. These states were chosen for their proximity to Minnesota, and known acceptance of wastes from Minnesota. Information was gathered concerning regulations targeting the reuse or disposal of sewage sludge ash, permitting requirements, and alternative beneficial uses.

Of the states surveyed, those that incinerated sewage sludge either landfill as a primary method of disposal or for special circumstances. In Illinois, there is no incineration of sewage sludge. Michigan disposes of all their ash in landfills. Missouri disposes almost all incinerator ash in landfills and requires each truckload to be sampled and tested for hazardous substances.

In Iowa, landfilling is the option most commonly used for managing sewage ash. Iowa requires that any waste characterized as a "special waste" be subjected to Special Waste Authorization Requirements (IO Admin. Code Ch. 200.2, April 16,1997 rule) prior to landfilling. This requirement establishes an application and review process for the landfilling of special wastes. Since sewage sludge ash is considered a special waste, landfilling of this material is subject to these requirements.

Land application in Iowa is split into two types: application on agricultural lands, permitted through the Department of Agriculture, and use in other situations such as site restoration, permitted through the Department of Natural Resources. If an alternative beneficial use is pursued, a request is made for an exemption to the Iowa Administrative Code Chapter 108 permit requirements. The request would include a description of the intended beneficial use, the character and amount of material to be utilized, and other relevant information. This process would be used if the ash were to be incorporated in bricks or concrete, or used in some other manner not covered by the previously-discussed permitting programs.

Many states have rules governing the "beneficial use" of ash. Minnesota does not have such rules, although over four years ago the MPCA established a task force to develop such rules. Very little progress was made partly due to the presence of waste-to-energy facilities hoping to establish rules for their ash. These facilities voluntarily removed themselves from the process, but little progress occurred regardless.

The Metropolitan Counties, in their Solid Waste Policy Plan completed in conjunction with the Minnesota Office of Environmental Assistance, have endorsed the beneficial use of ash from waste-to-energy facilities and rulemaking for ash utilization. There is also interest in out-state Minnesota and on October 15, 1997, a grant application for a pilot project for solid waste ash utilization was submitted to the State by Polk County.

Northern States Power (NSP) has attempted to permit coal ash utilization projects recently. NSP believes restrictions such as those placed by the MPCA on MCES are not environmentally justified, but to date NSP has not been successful in negotiating a less restrictive permit.

As of the completion of this ash market study, attempts at adopting rules in Minnesota for the beneficial use of any kind of ash (coal, sewage sludge or solid waste) have failed.

III. Present Ash Utilization at MCES

A. Herzog Environmental, Inc.

MCES contracts with Herzog Environmental, Inc. to manage most of the ash generated at the Metro and Seneca Plants. Mr. Joe Kneib, General Manager for Herzog, was interviewed and provided the following information.

Herzog is an environmental company involved in managing MSW landfills, recycling wood waste and green waste, and beneficially using ash. Their main business is in railroad and heavy construction projects, and they own a large fleet of railroad cars.

Herzog's contract with MCES is a "turnkey" contract; that is, Herzog assumes full responsibility through the contract to beneficially use ash generated by the Metro and Seneca plants in exchange for payment of $53 per dry ton. In order to fulfill this responsibility, Herzog has made considerable investments, including spending over $500,000 in testing of products made using ash to respond to market requirements.

Ash is marketed from the Metro Plant in both the "conditioned" form, which has moisture added, and in the dry form. Metro Plant staff add water when Herzog plans to use the ash in a conditioned form. Approximately 20 to 25% of the ash is conditioned. The remaining 75 to 80% is marketed as dry product.

The primary uses for ash at this time are for: structural fill, flowable fill, and concrete additives. Ash ends up in products which are sold in Minnesota, Wisconsin, Missouri, Kansas and Iowa. A review of monthly reports submitted to MCES by Herzog show that much of the ash produced at the Metro Plant is going to Holnam, Inc., in Mason City, Iowa, via their contract with Herzog. Holnam uses the ash as a raw material in cement manufacturing (mineral filler in the production of portland cement). Smaller amounts are marketed to Cemstone, which is located in close proximity to the Metro Plant. This Cemstone plant is owned by Herzog, and uses the ash in producing flowable fill which is marketed to various businesses in the Twin Cities metro area. Some of these businesses are under contact with MCES for capital projects.

It is Herzog's goal to find markets for ash as close to the Plant as possible in order to avoid transportation expense. Herzog has invested considerable resources to develop markets, and has approached numerous businesses in Minnesota and Wisconsin. The primary barriers to marketing sludge ash are:

- Sludge ash is a unique material to the marketplace. The markets are familiar with sand, rock, gravel, etc, but must be educated about the properties of sludge ash.
- The supply of ash as a construction material is relatively small compared to other feedstocks. The markets must be appropriately sized.
- Compared to other materials, ash requires special handling.

Given the goal of minimizing transportation costs, large markets in the Metro Area are considered appealing. One market that Herzog has tried to develop is Mn/DOT. Mn/DOT could potentially use the ash material in bituminous pavement and asphaltic cement on many projects. In addition, if Mn/DOT develops specifications for the use of sludge ash, cities and counties in Minnesota which rely on Mn/DOT's specifications will also be potential new markets for ash.

Herzog has been attempting to gain acceptance from Mn/DOT since 1991. As of this date, Mn/DOT has still not approved the use of ash in asphalt mixes, however, it is Herzog's goal to receive approval in time for the 1998 construction season. According to Mr. Kneib, Mn/DOT representatives have indicated that Herzog is "head and shoulders" above other vendors in terms of their testing of their materials and the work they have done to compile information on the structural and environmental aspects of ash use. In spite of this, Mn/DOT has been reluctant to use the material mostly due to liability concerns (According to Mr. Kneib, Mn/DOT has requested indemnification language in draft contracts which exceeds that which they would require for any other materials which they procure). Herzog plans to continue to work with Mn/DOT to overcome barriers to using Metro Plant ash in major road construction projects in Minnesota.

Regarding pricing considerations as they relate to building stronger local markets for ash, Mr. Kneib indicated that Herzog is interested in discussing price reductions with MCES if local market such as Mn/DOT come to fruition, and if MCES is willing to consider a contract extension beyond the existing contract term.

Of the present uses for ash, some use more ash as a proportion of the total product than others, as the following shows:

- Concrete - up to 5 to 10% ash (replacing some sand and fly ash requirements for the concrete.
- Flowable Fill - 50 to 90% ash.

With regard to other vendors who might also provide ash utilization services, Mr. Kneib indicated that since most municipalities landfill their sewage ash, there is not much activity in this area. In addition, he indicated that not many, if any, other companies have a track record in terms of longevity and performance in managing sewage ash.

With regard to the future of marketing ash from a fluidized bed incinerator system, Mr. Kneib indicated that the higher moisture content in the ash will present marketing challenges, but he does not see this as a significant concern. Herzog was involved in removing and utilizing ash from storage basins during the first few years of their contract with MCES, and this material had a relatively high moisture content.

B. Rehbein

The MCES contract with L&G Rehbein, Inc. calls for the utilization of sludge ash as a source of phosphorous and micro nutrients in a blended mix with lime sludge. Rehbein is responsible for obtaining and hauling lime sludge from water treatment plants in Minneapolis and St. Paul to the Metro Plant for blending, and utilizing the blend for land spreading on farmlands.

MCES provides that the ash loaded out from silos will be consistent in its physical and chemical characteristics and shall be approximately 20% moisture content. MCES is a partner in the development of "NutraLime" and is responsible for providing a location for blending ash with lime slurry, and for the blending of NutraLime. Marketing of the blended ash and lime product is a cooperative effort between Rehbein and the Council. At present, end users do not pay any fees for the product or its application. The product is used in agricultural applications as a liming agent or as a fertilizer. Due to operational convenience, ash used for NutraLime has originated from the Seneca Plant, while Metro Plant ash has been managed by Herzog.

In 1996, 4,200 wet tons of NutraLime were generated with 2,600 tons of dry ash from the Seneca Plant. MCES paid $12.50 per ton to Rehbein which translates into approximately $20.00 per dry ton of ash. Additional costs associated with the production of NutraLime include MCES staff costs for the blending operation and marketing activities. Rehbein's prices were reduced dramatically approximately 2 years ago, making this activity more economical. While a market for this product has been developed, the demand for the product is weak; farmers are interested in lime, but have concerns about phosphorous loading which may occur at unacceptable levels as a result of the ash component of NutraLime.

Effective November, 1997, ash from the Seneca Plant will be managed by Herzog and NutraLime production will be discontinued. Future operations are uncertain at this time.

IV. Management Practices at Selected Facilities in Other Parts of the Country

Several wastewater treatment plants across the country were contacted to assess opportunities for ash utilization. The upper Midwest region was targeted, focusing on communities somewhat similar to the Twin Cities metropolitan area. In addition, communities actively involved in significant ash utilization programs were contacted. Table IV-1 summarizes the results of this review.

A. Metropolitan St. Louis Sewer District

Jeff Theerman, Assistant Director of Waste Water, was interviewed regarding ash management at the Bissell Point and LeMay facilities. Bissell Point has six multiple hearth incinerators and LeMay has four multiple hearth incinerators. Bissell Point generates approximately 100 tons per day of dry sludge which in turn generates approximately 40 tons per day of dry ash. Both facilities sluice the ash with water and transport it to ash basins. Two Bissell Point ash basins have approximately 85,000 cubic yards of capacity allowing for approximately 15 months of storage. At approximately 15 month intervals the ash is removed from the basins and delivered to a landfill. At the time the ash is transferred it contains about 40 to 50% moisture.

The Sewer District owns their own ash landfill and the have recently completed an internal cost analysis which shows that the cost of landfilling is approximately \$45 to \$50 per dry ton of ash. They have approximately 20 years of capacity remaining in their landfill, however, they are also planning for future alternative ash management options. They have spoken to local cement dealers and have also been approached by Scotts fertilizer company with inquiries about using ash. Mr. Theerman indicated that Scotts was interested in working with them only if they would build a manufacturing plant for Scotts and also pay a per ton fee to utilize ash.

In Mr. Theerman's assessment, using ash as an additive in cement and brick-making are some of the best options presently available for ash utilization.

B. Northeast Ohio Regional Sewer District

Bob Dominak was interviewed about the three facilities incinerating sludge in Cleveland, Ohio. The three facilities are named Easterly, Westerly and Southerly. The Easterly facility processes only grease and scum and generates very little ash since these materials are 95% volatile organic compounds. The Westerly facility has two incinerators which process approximately 8,000 to 9,000 dry tons of sludge per year. The Southerly facility manages approximately 90,000 wet tons of sludge per year. Ash from Southerly was used in the past to fill low land areas.

With regard to present management of ash, the ash from the Southerly facility stays on sight in a storage/fill area. This area has an additional eight years of capacity. Ash from the Westerly plant is hauled to landfill. Mr. Dominak indicated that the district is beginning to look at long term options for managing ash since the capacity of the Southerly site is limited. They have spoken to various contacts about brick manufacturing. However, a reliable end market has not yet been identified. Mr. Dominak suggested that the present surplus of landfill capacity has lessened the importance of identifying ash utilization options, however, he also feels that, in time, most communities will move away from landfilling.

C. Columbus, Ohio

Approximately 50% of Columbus' sewage waste stream is incinerated, 25% is land applied, and 25% is composted. Ms. Angela Bianco is responsible for marketing sewage sludge compost as well as ash from two waste water treatment facilities serving Columbus. Ms. Bianco described the marketing program which she initiated for Columbus' ash.

Columbus' ash has a particular bright red-orange color due to the polymers used in their incineration process. It absorbs water well and has a texture which makes it a good quality substitute for brick ash used on baseball diamonds and horse arenas. Ms. Bianco worked with a local trucking company already under contract with the District to market their ash, which they called "flume sand". They had some success in marketing flume sand to local high school athletic associations for athletic fields. The flume sand was marketed at a price of $1.00 per cubic yard for unscreened material and $4.00 per cubic yard for screened material. Most purchasers were interested in the more expensive screened material. The flume sand was a substitute for brick dust, which has a coarse texture, is abrasive, and stains clothes; brick dust also sells for a higher price than flume sand.

While Ms. Bianco felt that the flume sand marketing strategy had very good potential, administrators to which she reports have suspended the marketing program. It has been determined that EPA approval should be sought even though it is not required. Test results have been sent to EPA for comment, however, no response has been received yet.

It should be noted that the ash generated from those facilities does not meet portland cement specifications (possibly due to the polymer that is used at the Columbus incinerators), and therefore, their ash cannot be used in concrete. Other utilization options are presently being considered, including using ash for landfill cover and making bricks with ash.

At present, Columbus is storing ash in lagoons and, at intervals, transferring the material to a landfill. The wet ton cost for transportation and landfilling is $29.83 per wet ton.

D. Hampton Roads Sanitation District

Ms. Rhonda Bowen, Recycling Manager for the Hampton Roads Sanitation District (HRSD) was interviewed and provided the following information. HRSD includes five treatment facilities which incinerate sewage sludge.

The five facilities generate over 16,000 of dry ash per year and the District contracts with Environmental Solutions, Inc. (ESI) for the beneficial use of ash. ESI has a partnership with a paper company in Richmond, Virginia whereby they compost combined paper sludge and biosolids. The ash is mixed with a concrete wash to produce "select fill" which is then used to fill in lagoon areas on the plant property. In other words, the ash is being used as a fill material which then supports the development of the compost facility.

The select fill material has also been used to build roadways at the facility and has been mixed with soil and cement to produce "soil cement" which functions like an asphalt pad. This would be similar to the MCES flowable fill.

Approximately 80% of the ash generated by HRSD is delivered to the Richmond, Virginia site. The remaining 20% is used for flowable fill and "Seabees". Seabees are six-sided concrete blocks which are used for erosion control projects. The ash is used as a fill material in the blocks and functions to make the blocks lighter and withstand environmental changes more effectively. Regulatory approval has been received for the blocks. A study was conducted by the Army Corp of Engineers in Virginia and other organizations who examined leaching properties and found no leachate concerns.

Ash utilization has been somewhat challenging in Virginia, however, because approval of uses has been on a case by case basis. Ms. Bowen indicated that there is a strong market for flowable fill, but contractors need product relatively quickly and gaining approval on a case by case basis in the appropriate time frame is challenging. The ESI option of filling in lagoons is considered a niche market, however, it is expected that the market should last approximately 10 years. HRSD pays ESI $20 per cubic yard to take dry ash and HRSD is reimbursed thirty-two cents per cubic yard for ash which is recycled. The net result translates to $36.40 <u>per dry ton</u> of ash which is recycled, including transportation. In comparing this cost to local landfills, Ms. Bowen indicated that landfilling would cost $47.41, including transportation. ESI also assumes ownership and marketing risks. HRSD is responsible for conducting TCLP tests.

According to Ms. Bowen the contract with ESI saves HRSD approximately $176,000 per year. If ESI was no longer able to manage HRSD's ash, Ms. Bowen feels that there are other vendors who may be able to offer utilization services since there are many vendors actively involved in recycling coal ash in this area. However, Ms. Bowen also indicated that it takes a special type of vendor who is interested in recycling a relatively small amount of ash compared to the amount of coal ash that is generated.

When HRSD became interested in looking for ash utilization options, staff researched a number of different locations across the country, but had difficultly finding models for ash use.

<u>Environmental Solutions, Inc.</u>

Environmental Solutions, Inc. (ESI) is a relatively small business located in Richmond, Virginia and providing service to the Hampton Roads Sanitation District (HRSD) in southeast Virginia. Brenda Robinson, vice president of ESI was interviewed regarding their operations. Ms. Robinson indicated that the business was started in 1990 with a focus on municipal and industrial waste materials that can be beneficially used. Their business perspective is to view waste streams as raw materials and to explore what products can be generated from these raw materials. In addition to utilizing sewage ash from HRSD they also work with coal ash and paper fibers to produce a variety of products. ESI strives to develop markets for the products generated from waste materials with the entity generating the waste. They call this a "closed loop" utilization, that is, waste material goes back to the site or system from which it originated. If they cannot achieve the closed loop marketing goal, their strategy is to explore opportunities for marketing products from waste streams in a close geographic area to the point of generation in order to minimize transportation costs.

At present, the primary use for HRSD sewage ash is as component of "select fill" which is being used to fill lagoons on the property of one of their customers, a newsprint and cardboard producer. ESI frequently partners with their customers to locate their operations on the property of their customers, and has developed a compost site with the paper company where paper sludge and bio solids are composted. This facility was built on an area with many lagoons and ESI provides additional service to the paper company by filling the lagoon areas with the select fill material from HRSD. In addition they have used ash in a soil and cement mixture to produce "soil cement" which functions like an asphalt pad under compost material. ESI charges HRSD $36 per ton for managing their ash.

Other uses of the ash, representing approximately 15% - 20% of the total ash collected, include using ash as an ingredient in "Seabees", which is the trade name for ash blocks produced by ESI. These blocks are being used for erosion control and landscaping, sell for $3.00 per block, and weigh about 50 pounds per block. Approximately 80,000 Seabee blocks have been produced. Most of the ash in a Seabee comes from coal ash and __% is from sewage ash.

According to Ms. Robinson biosolids ash is a challenging product to market in the building and construction industries since it has properties that negatively impact compressive strength.

In response to questions about how ESI markets their products, Ms. Robinson indicated that they participate in Earth Day activities, ash utilization seminars, and offer presentations to schools and other organizations. ESI also produces a product called "biocritters" which they have used as an environmental awareness tool to promote the beneficial use of biosolids.

ESI has a revenue sharing agreement with HRSD, however, this agreement is not directly based on revenue received from marketing ash products, but rather pays HRSD thirty-two cents per cubic yard for ash which is recycled. With regard to liability issues, ESI indicates that they assume responsibility for ash at the HRSD facility. They collect the material in large containers, apply a minimal amount of water, and transport ash to the compost facility located on the paper company site. Ash hauled from the five HRSD facilities is hauled anywhere from 60 to 120 miles.

Another use of ash by ESI is as structural fill. Ms. Robinson indicated that this usage is for dirt replacement, road base and to fill in lowlands. If ash is used as a structural fill, the value is approximately $2 to $4 per cubic yard.

E. Palo Alto, California

Palo Alto contracts with a broker, Offset Agri-Industries, to manage their ash. The ash is given away to farmers, who find the phosphorus in the ash to be beneficial. Offset Agri-Industries continues to look for new options for managing the ash, but they indicate that perception problems in marketing a waste product must be overcome. Among the options they are considering are using ash in road base, for landfill cover, and as a concrete additive.

Landfilling prices in the Bay Area are $45 - $50 per ton including transportation, and the avoidance of this cost is seen as a benefit, even if the ash product must be given away rather than sold.

F. Other Communities Interviewed

<u>Metropolitan Sewer District of Greater Cincinnati</u>

Michael Heitz was interviewed, and described Cincinnati's sewer treatment system at the Mill Creek Wastewater Treatment Plant. They incinerate sewage sludge, and generate about 40 tons per day of dry ash. Ash is sluiced into a lagoon, which is periodically dewatered, and the ash trucked to an MSW landfill. The District paid $15.43 per cubic yard to remove ash from the lagoon in 1997. This cost included partial dewatering of lagoon and ash prior to removal, removal of ash from the lagoon, hauling fees, tipping fees, and permit costs.

<u>Green Bay Metropolitan Sewer District</u>

Bill Debauche, Operations Manager, was interviewed. Green Bay generates about 2,800 tons of dry ash per year. They presently landfill the ash at a facility located 15 miles from the plant. The landfill tip fee is $24.50 per ton. The District looked at using ash as a light-weight aggregate about 6 years ago, but did not pursue this option.

V. Summary of Identified Options for Managing Ash

A. Ash Management Options

The review of ash utilization activities in other parts of the country indicates that ash uses which are considered most promising are using ash in construction materials, and as an ingredient in land spreading activities. A summary of uses is as follows:

1. Flowable Fill
   Flowable fill is a product that is used for: backfilling of excavations, placement of underground pipe, man holes, building foundations, footings, abandoned tanks, all types of utility cuts, and any other type of application where it is advantageous to use a low strength controlled density fill. The use of flowable fill is relatively new (within the last five years), and therefore, market potential is growing.

   Various percentages of ash and sometimes other aggregate or soil are mixed with up to 15% cement to obtain the desired strength.

2. Other concrete, cement, asphalt products
   Ash can be introduced in a number of construction products, including concrete, cement, asphalt products, and serves as a mineral filler in these products. It substitutes for sand and coal ash.

3. Landfill cover.
   Landfill operations require the application of cover material daily in order to minimize the escape of particulates and litter. If no other suitable material is available, soil is used as a cover material. Some sewer treatment districts manage their ash from sewage incineration by giving it to landfills to be used instead of soil for daily cover.

4. Bricks and brick filler.
   Many types of bricks and blocks are manufactured, and ash can be used as a filler material in the manufacture of bricks and blocks. Coal ash is the ingredient more commonly used in this manufacture.

5. Land application.
   Ash has fairly high levels of phosphorus which is desirable for land application in parts of the country which are phosphorus-poor. In addition, ash can be blended with a soil nutrient such as lime (as in Minnesota) which is more in demand by agricultural and horticultural markets.

B. Vendors

This study endeavored to find other ash utilization operations to consider, as well as vendors of ash use services. Few were found, since most districts are not utilizing ash. Those who are developing programs for ash use, are working with local companies to develop programs to meet their specific needs. Some of the districts that were interviewed said that confidential discussions with unnamed vendors were underway, so new ventures may be emerging over the next few years.

C. Landfilling opportunities

Although landfilling is not an ash management method available to the Metro Plant at this time, this study includes an update on potential landfilling options to allow for comparisons with beneficial use. Hennepin County recently competitively bid the landfilling of its MSW incinerator ash. The low bid was approximately $19 per ton including transportation to an industrial landfill in Rosemont, Minnesota. As the selected vendor, the Rosemont facility is now in process of preparing an environmental impact statement. If necessary approvals are obtained, construction on an ash monofill will begin in the summer of 1998, with operations beginning in 1999. The next two lowest bids received by Hennepin County were Superior Sanitation at $35 per ton including transportation to the Superior, Wisconsin, and $36 per ton including transportation to the Kalmar landfill in Olmsted County, Minnesota.

VI. Pricing Analysis

This section of the report presents an analysis of the cost to beneficially use sewage sludge ash produced by the Metro plant over the next twenty years. Such an analysis involves an assessment of both existing and emerging markets for this material. The purpose is to prepare cost estimates to be used in a life cycle cost comparison of incineration and drying technologies. For the MCES Solids Project, the planning period has been assumed to be 2005 through 2025.

Local end markets for ash are considered the most desirable, since transportation costs comprise a significant portion of the total cost to manage ash. Based on typical industry costs of $0.15 per loaded ton mile, Herzog's cost to transport ash to Mason City from the Metro Plant is estimated to be approximately $18/Ton, or 33% of the cost paid to Herzog by MCES.

The pricing analysis focuses on three factors affecting future costs: 1) consumers of sewage sludge ash and their needs and product preferences; 2) the nature of the market for ash and factors affecting the ability of that market to accommodate additional ash; and 3) the risks of unanticipated future cost growth to MCES as a result of beneficially reusing its ash in accordance with Council policy.

A. Consumer Analysis

Future costs and revenues related to ash utilization will be driven by the needs and preferences of potential consumers. This study shows that the potential market for sewage sludge ash and other ash products could be very large and comprised of multiple segments, or groups of consumers with similar needs and preferences.

Market Segments. Table V-1 presents markets which have been identified through this study. Markets include those that currently utilize an ash material or a close substitute in their operations.

TABLE V-1
Existing and Potential Ash Markets and Market Segments

Market	Use	Needs and Preferences
Cement Manufacturers (5 in Minnesota)	**Alumina, Silica, Iron Binder**	**Low Moisture, Uniform Quality**
Building Materials Manufacturers (32 in metro area)	**Asphaltic Concrete, Road Base / Subbase, Other Select Fill**	**Seasonal, Uniform Quality**
Brick Manufacturers (23 in Minnesota)	**Brick and Other Masonry Specialty Products**	**Low Moisture, Uniform Quality**
Paving and Roadway Materials (11 in Metro, 12 outstate)	**Asphaltic Concrete, Road Base / Subbase, Other Select Fill**	**Seasonal, Uniform Quality**
Landfill Operators	**Daily Cover**	**Uniform Quality, Variable Moisture, Nutrient Content**
Mining Companies (15 in Minnesota) (Reclamation)	**Nutrient Additive for Replacement Soils**	**Uniform Quality, Variable Moisture, Nutrient Content**
Agricultural / Horticultural	**Nutrient Additive for Soils; Material mixed with lime from water treatment facilities**	**NA**

Initial analysis indicates that MCES' ash would be able to meet the needs and preferences of some of these market segments.

Needs and Preferences. Regardless of the market, it can be assumed that consumers prefer a product that is not defined as a hazardous waste and contains limited amounts of heavy metals. Additional analysis of market needs and preferences depends upon each market segment. Factors which need to be assessed include: moisture content, mineral and nutrient (phosphorus) content. The polymers used in the incineration process can also be an important factor, as seen by the Columbus, Ohio, example where the polymer used defined the possible uses for their ash.

MCES ash could be attractive to a variety of markets, since it is not a hazardous waste, does not leach heavy metals beyond currently acceptable levels, can be marketed in a dry or conditioned form, and has some minimally attractive nutrient content. Existing markets, however, have different quantity and timing needs. Cement manufacturers are somewhat limited by the amounts of ash they can incorporate into their cement since too much may reduce the strength or workability of the concrete. Building materials manufacturers and pavement contractors are able to use ash as an ingredient in asphaltic concrete and as an admixture in roadway base and subbase. This segment is largely seasonal in nature in the upper Midwest. Mining companies in Minnesota could potentially use very large quantities of ash but are particularly concerned about potential future liability that may arise from the use of sewage sludge ash in mine reclamation projects.

MCES' present contractor, Herzog, markets the ash to multiple end markets. Herzog is able to sell all of MCES' ash, despite changing seasons and business conditions. This condition is considered a stabilizing factor when evaluating future cost projections. Absent the agreement with Herzog, MCES could expect to continue to utilize multiple markets to dispose of its ash, either through the efforts of another broker or by directly selling it to end markets.

Substitute Products. Sewage sludge ash may be considered a partial substitute for coal ash as well as other materials that are designed to provide a specific mineral or nutrient. Most building product markets are familiar with coal ash, particularly the cement manufacturers and building materials manufacturers. The ability of sewage sludge ash to substitute for coal ash which end markets are already familiar with may be considered a cost-stabilizing factor. While sewage sludge ash does not have the pozzolonic qualities of coal ash, it is being used successfully in asphaltic concrete and pavement materials where high strength is not critical.

B. Demand Analysis

The potential market for sewage sludge ash may be large. An analysis of the market demand for ash is considered a second factor affecting cost stability over the next 20 years. Such an analysis includes an evaluation of market maturity, an assessment of distribution channels, product differentiation and the cost to end markets for switching to sewage sludge ash from another material. These factors are summarized in Table V-2.

The market for MCES' ash is primarily constrained by lack of experience in using this material, reluctance to use a waste product, and concerns about environmental liability.

In addition, geography and the cost to transport the ash to end markets act as practical constraints. At the current $53 per dry ton paid by MCES, the break-even is approximately 277 miles (assuming $0.15 per loaded ton-mile and 20% profit). That is, to transport MCES ash beyond that distance, an end market must be willing to pay over and above the cost to transport the material 277 miles.

Fluidized bed incineration technology is assumed to produce an ash material that is slightly higher in moisture content than that produced using the existing multiple hearth incinerators. This is assumed to have minimal effect on the ability to market ash in the future. According to staff at the Western Lake Superior Sanitary District, lightweight aggregate manufacturers who have analyzed the ash produced at the District (in fluidized bed incinerators) were not concerned with the moisture content. In fact, they appeared to like the ash due to its sandy consistency that is a result of the fluidized bed incineration process. They remarked that such ash would be better suited to manufacture of a lightweight aggregate. In addition, the present vendor, Herzog, indicated that an increase in moisture content of ash would not diminish markets significantly.

TABLE V-2
Ash Market Characteristics

Market	Observation	Conclusion
Maturity – Is There Too Much Ash?	**Market is immature. To enter a new market, introductory or predatory pricing will probably not have to be employed.**	**Significant opportunity for market expansion, particularly locally. *Expected depressing effect on future pricing.***
Distribution Channels – How is the Ash Distributed to End Markets?	**Primarily by brokers that serve multiple markets. Could be supplemented with direct sales to local manufacturers and other markets.**	**MCES could continue to work through broker relationships. *Stabilizing effect on pricing.***
Product Differentiation – How Can/Does Sewage Sludge Ash Differentiate Itself?	**Nutrient content (Phosphorus).**	**Some opportunity for market expansion, particularly locally. *Expected depressing effect on future pricing.***
	Environmental concerns (long-term liability).	**Reluctance to use waste product must be overcome. *No effect on future pricing.***

Market	Observation	Conclusion
Switching Cost – Is There a Cost for Markets to Switch to Sewage Sludge Ash?	**None noted.**	**Including language in MCES construction projects to require the use of ash could affect decisions based on switching costs. *No effect on future pricing.***

C. Price Risk Factors

Table V-3 presents several risk factors associated with the future cost of beneficially using MCES sewage sludge ash. Since the markets for ash are diverse, the failure of any single market may not have an appreciable affect on pricing. However, the biggest risk affecting the future cost to beneficially use ash is probably concerns about environmental impacts and long-term liability.

TABLE V-3
Ash Pricing Risk Factors

Risk Event	Consequences	Pricing Impact	Likelihood
Ash classified as a hazardous waste.	Inability to beneficially use ash through existing markets. Must dispose of or utilize more exotic, experimental markets.	Very high	Low
Cheaper substitute product becomes widely available.	Increased cost per ton.	Moderate	Medium
Ash rejected by roadway contractors.	Increased cost per ton.	Moderate	Medium
Ash rejected by cement manufacturers due to quality or strength issues.	Increased cost per ton.	Low	Medium
Ash rejected by mining companies due to liability concerns.	Increased cost per ton.	Moderate	Low
Switching Cost – Is There a Cost for Markets to Switch to Sewage Sludge Ash?	None Noted	Very high	Low

VII. Summary Conclusions

The market for sewage sludge ash appears to be promising in the coming years due to the number of different uses for ash, and the size of each of the various market segments. Marketing potential has not yet been fully realized, and significant barriers to successful market expansion exist. Among the most significant barriers are the acceptance by end-users of a somewhat unique waste material, and concerns about long-term environmental liability.

Based on research of beneficial use of ash around the country, it appears that the Metro Plant is at the cutting edge of ash use activities. The present contract with Herzog has allowed MCES to fully achieve their goal of beneficially using 100% of ash generated at the Metro and Seneca Plants. Interest in beneficial use of ash is expected to grow in other parts of the country as landfill capacity diminishes and an environmental ethic for the use of residual waste streams becomes more pervasive. At least a few Midwest sewage districts have begun work on identifying ash utilization opportunities, and districts in Virginia and California are presently building successful ash use programs.

The future cost to beneficially use ash from the Metro Plant will to be related to the existence of commercially viable and sizable local markets. As local markets continue to develop, the cost to MCES for ash utilization is expected to decrease. Of these local markets, cement manufacturers, mining companies, and roadway materials manufacturers appear to be the most promising. Mn/DOT could be a major end-user. With regard to long-term price stability, the number of markets available means that the failure of any single market is not likely to effect the overall cost.

MCES Heat Dried Biosolids Fertilizer Market Analysis

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Appendix E

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Executive Summary

The purpose of this study was to determine and communicate the market potential of a Heat Dried Biosolid Fertilizer (HDBF). The content of the study will be considered in determining the feasibility of a biosolids heat dryer for wastewater solids treatment for the Metropolitan Wastewater Treatment Plant (MWWTP). The MWWTP is operated by the Metropolitan Council Environmental Services (MCES) Agency in Minneapolis, Minnesota. The MWWTP HDBF facility would initially (year 2005) have an annual production of either 53,000 tons of high quality product, or 92,000 of a lower quality product.

Producing a HDBF often reduces wastewater solids disposal costs and generates revenue that can offset the drying costs. Heat drying does not eliminate the risk of disposal costs. Revenues and market share have disappointed some HDBF producers. In the past 5 years there has been a significant increase in HDBF producers. This competition has saturated some HDBF markets resulting in reduced revenue for most producers. The HDBF also competes with chemical fertilizer products sold by commercial fertilizer companies with nationwide distribution. HDBF does not compete well with chemical fertilizers because of its low nutrient concentration levels. This excludes HDBF from the typical agriculture distribution channels.

A successful HDBF sales program will require the hiring or creation of a HDBF business with capabilities in sales, marketing distribution and application. The MWWTP HDBF market would need to focus primarily on local agriculture with Specialty Fertilizer Blenders as a secondary market. If the product is well received and all the appropriate resources are dedicated to the project, it could take four years to develop a market that could purchase the entire MWWTP HDBF production. After four years of market development effort MCES may see average revenues of:

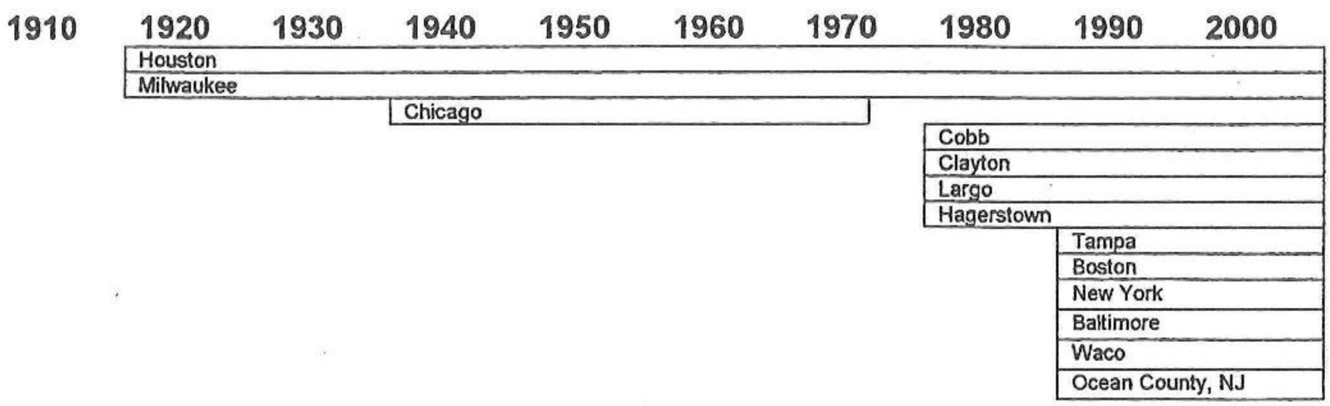
Product Type	Tons/year	$/ton ave.	Agriculture Market		Specialty Blender Market	
High Quality	53,000	$7.3	41,000 tons/year	$5/ton	12,000 tons/year	$17.50/ton
Low Quality	92,000	$5.00	92,000 tons/year	$5/ton	0	0

If the product is not accepted in the local agriculture market, MCES could incur disposal and freight costs (the determination of those costs is not within the scope of this study). It is highly recommended that MCES conduct HDBF local agriculture test market research before committing to the construction of a Heat Drying Facility. This research should include actual HDBF product sales and applications.

History of Heat Dried Products

In the early 1900s some urban centers were realizing the benefits of sub terrain sewage systems. Wastewater treatment consisted of discharging the raw sewage onto local cropland. The value of the sewage as a fertilizer was obvious since farmers had been using sewage and manure for generations. Concern that the raw sewage would seep through the soil and contaminate local well water supply encouraged the development wastewater technology. The basics of that technology were to separate the solids from the water and treat the two separately. In the 1920s, Milwaukee and Houston built heat-drying facilities to treat wastewater solids. The dyers produced a dry, pathogen free product that could be handled and stored like any granular fertilizer. The product could also easily be shipped a good distance and sold to offset treatment costs.

Other municipalities were slow to accept drying technology. Deterrents to drying might have been high capital costs, higher operating costs than other disposal options, and infrequent fires at existing drying and storage facilities. The following time line shows the approximate times these municipalities produced heat-dried biosolids.



The above list is not intended to be totally inclusive. It is intended to show the increased competition in HDBF. Today there are approximately 20 production facilities producing approximately 300,000 tons of HDBF annually. This is up sharply from 1990 when the annual production was near 100,000 tons. The revenues that the HDBF producers receive vary greatly. Some producers often subsidize the sale or pay disposal fees for product that is not sold. Currently, there is a renewed interest in drying along with more options for equipment vendors, contract operators and HDBF marketing companies.

Heat Dried Biosolids Fertilizer (HDBF) Value

The value of a HDBF can be considered from two aspects 1) HDBF Chemical fertilizer value 2) HDBF Organic fertilizer value.

1) HDBF Chemical Fertilizer Value

The majority of fertilizers consumed in the US are chemically processed granular fertilizers. Heat drying biosolids is intended to produce a product that has many of the characteristics of granular fertilizer. A HDBF can be stored, handled, bagged and blended similar to common granular fertilizers. In general, the chemical fertilizer industry determines the value of a product by its primary nutrient content specifically nitrogen, phosphorus, and potassium (NPK). Organic benefits and micro-nutrients are often overlooked. This chemical model for evaluating fertilizer value dominates the fertilizer market. The nutrient content for a typical HDBF is shown in table 1.

Table 1 HDBF Nutrients

HDBF Nutrients		Micro Nutrients	
Nitrogen	6.10%	Boron	**
Water Insoluble	5.70%	Cobalt	**
Water Soluble	0.40%	Chlorine	0.10%
Phosphorus (P205)	3.10%	Copper	0.03%
Potash	0.50%	Iron	2.30%
Carbon	22.0%	Manganese	0.06%
Calcium	0.90%	Molybdenum	**
Magnesium	0.40%	Nickel	0.01%
Sulfur	0.70%	Zinc	0.07%

In the chemical fertilizer industry nutrient concentration is a primary concern. The more concentrated a product is the less of it is required. Higher concentration of nutrients reduces freight, storage and applications cost. Table 2 compares a HDBF with urea, a common chemical nitrogen fertilizer. It shows the major disadvantage of a HDBF, to the chemical fertilizer industry, is the lower concentration levels. Urea is eight times more concentrated than HDBF. Basically HDBF application, freight and storage costs are eight times more than urea on an equivalent nutrient basis.

Table 2 Nutrient Density

Characteristics	Urea	HDB	Manure
Density lbs/cu-ft	45	40	35
% Nitrogen (N) by Weight	46%	6%	1%
Nutrient Concentration by Weight (lbs-N/ton)	920	120	20
Nutrient Concentration by Volume (lbs-N/cu-ft)	20.7	2.4	0.35
Relative Concentration Level	8.6	1.0	0.1

Another negative characteristic of a HDBF is the problems associated with the decomposition of organic products. If processed, handled, applied or stored inappropriately HDBF can rot creating an awful odor and can spontaneously combust. Even when used correctly HDBF has an odor that can be offensive to some for several days after application. The fact that the product is derived from sewage may also lower its value in the chemical fertilizer industry. Many in agriculture are concerned about the potential negative perceptions of using a HDBF on food crops.

1) Organic Fertilizer Values of HDBF

The basic difference between chemical fertilizers and organic fertilizers is that organic fertilizers are a food source to the soil organisms. This model for evaluating fertilizer is more biological than chemical. Those that aspire to organic agriculture believe that by feeding the soil organisms you promote a healthier more productive environment for the plants. Organic fertilizers have so many benefits that they sound to good to be true although many of the claims are substantiated from reputable sources. Attached is an article from a Dallas newspaper that does an excellent job summarizing the benefits of organic gardening. Also attached is a flow chart[i] that explains organic benefits from a soil science perspective. Organic fertilizer benefits include:

- Contains micro-nutrients, vitamins, complex organic compounds.
- Improves mineral availability and uptake by plants.
- Reduces water requirement, improves soil drainage properties.
- Slow release, less waste, environmentally safe.
- Improved disease resistance – Healthier more productive plants.

HDBF is an excellent food source for the multitude of soil organisms and therefore an excellent organic fertilizer product. HDBF products have been sold for feed to earthworm farms. HDBF is one of the highest sources of vitamin B known. Compared to other organic products (e.g. manure) HBDF is relatively concentrated (see Table 2). HDBF has all the benefits of an organic product and it is easy to handle, store and apply. Those concerned with organics may see HDBF as a premium product. The sales price of an HDBF sold by its organic values can be more than twice that of an HDBF sold by its chemical values.

The benefits of organic fertilizers are most prevalent in soils that have low organic matter. HDBF products are very popular in the sandy soils of Florida.

US fertilizer distribution network

The fertilizer market is mature and extremely competitive. Market share is gained at the expense of the competition. New fertilizer products are sold by displacing existing products. Producers, wholesalers and resellers have built an extensive distribution network (see figure 1). Existing business relationships make it difficult to introduce a new product at any point in this hierarchy. Relationships are maintained by efforts that ensure resellers profit from marketing the product. Each position in the hierarchy adds value to the product or provides a service to their customer.

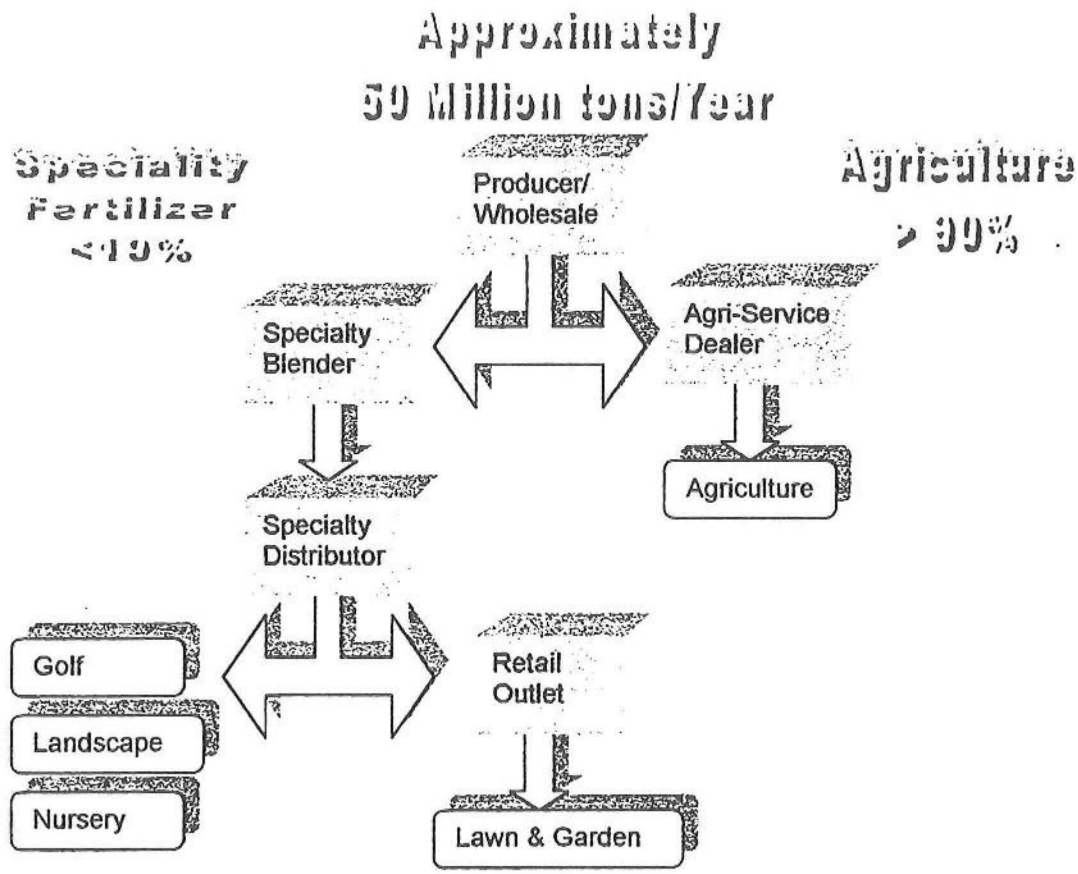


Figure 1 US Fertilizer Distribution

Producer/ Wholesale

Approximately 50 million tons of fertilizer is consumed each year in the US. The majority of the product is sold to Agri-Service dealers for spring application. Some is sold directly to large agriculture users.

Agri-Service Dealer

There are approximately 5000 Agri-Service Dealers[ii] in the US. Their customer base is within a 15-mile radius of their facility. They are intimate with the farmers and provide a multitude of services with the sale and application of the custom blended fertilizers, pesticides and herbicides. As with most businesses, customer service is as critical as the product. Most of the Agri-Service Dealer's annual revenue is made during a few weeks in the spring and fall when the fertilizer is applied. If dealers can not apply during those weeks, they miss the sale. The agriculture industry pays them according to the acres covered. Agri-Service Dealers buy exclusively concentrated chemical fertilizer products because of the high application rates and low application costs. In general they will not buy the less concentrated HDBF (see table 2) because they can apply eight times the chemical fertilizer in the same amount of time. In the busy spring season, an Agri-Service Dealer will lose money with an HDBF even if it is delivered to them for free.

Agriculture

The agriculture market (farmer) consumes the vast majority of fertilizer sold. The fertilizer products are usually sold and applied by Agri-Service Dealers. Some large farms may buy their fertilizer directly from a wholesale distributor and apply it themselves. This market for the most part buys fertilizer based on its chemical nutrient value. There seems to be a growing awareness of the benefits of organic products but most continue to buy chemical products exclusively. Farmers are familiar with wet biosolids land application but many are not aware of HDBF. Still the majority of HDBF produced has been sold and given away to a farm near the facility. The keys to getting the farmer to pay for the HDBF are: 1) Create a demand for the HDBF. The farmer will not pay if he thinks he will get it for free by waiting. 2) Make it easy for the farmer to buy and use the product. Provide the delivery and application service he is accustomed to from the local Agri-Service Dealer. 3) Initially price the HDBF below the chemical nutrient value of competitive fertilizer products to encourage the farmer to try the HDBF. There are many farmers that believe there are risks associated with using HDBF and will require a monetary incentive to take the risk. Agriculture is a high volume low margin market. Some farmers can buy several thousand tons annually.

Specialty Blender

Specialty Blenders purchase a multitude of fertilizer products and produce precise blended fertilizers. They also mix fertilizers with herbicides and pesticides. A large Specialty Blender might sell 100,000 tons in a year but most are small and would sell less than 40,000 tons annually. They sell truckload quantities of finished product often shipping into several states. Their products are made to order and put into proprietary bags for Specialty Distributors. Some Specialty Blenders also act as Specialty Distributors and Agri-Service Dealers. Specialty Blenders use the HDBF in the specific product blends. They can purchase and store truck and railcar quantities. Blenders are medium volume medium margin accounts. A good blender might buy 2000 tons of HDBF annually.

Specialty Distributor

Specialty Distributors understand the unique requirements of the customers that they serve. They use market specialized sales staff and might sell other products in addition to fertilizers. They often have some finished product storage and can ship mixed product loads to low volume customers. Specialty Distributors deal in bagged fertilizers almost exclusively. Many deal in HDBF products. These are low volume (200 tons annually) medium-high margin accounts.

Golf

Nursery

Landscape

This group of customers is acutely concerned with the quality of their plants, especially appearance. They are far less concerned with fertilization costs, including application, then the farmer. The values of HDBF are widely recognized with these end users probably because of the marketing efforts of Milwaukee's HDBF (Milorganite®). These are treasured customers buying almost exclusively bagged product from sales people they have a good relationship with. This is a mature low volume, high margin, and high effort per unit of volume, competitive market. A good golf course customer might buy only 20 tons of bagged HDBF in a year 2 tons at a time.

Retail Outlet

Lawn & Garden

Garden centers across the country are packed with a multitude of fertilizer products, chemical and organic. They stock a couple pallets at a time of each bagged fertilizer product on the sales floor. They take delivery of mixed product truckloads when they reorder. A primary concern is limited floor space; they are not looking for another fertilizer product. Retail is very price competitive and prefers well-known brand names. Retail is the only practical way to sell HDBF to the Lawn & Garden market and a Specialty Distributor is the only practical way to get a HDBF product to Retail. There is a growing awareness of organic values but there is no shortage of products or fertilizer companies wanting to expand (e.g. Scotts).

Specific producer information:

Milwaukee, Wisconsin
Production 50,000 tons
Facility owned and operated by Milwaukee Metropolitan Sewage District
Marketing by MMSD Marketing Dept.
Product Analysis: 6% Nitrogen, 3% Phosphate 0% Potassium and 4% iron.

Milorganite has been in production since 1926 and is the HDBF market leader. It can be purchased in many stores and in most cities. Milorganite is well known and respected in the retail, golf, turf and nursery industries. The Milwaukee Metropolitan Sewage District (MMSD) has a marketing department with a staff of approximately eight people dedicated to selling Milorganite. Milorganite is mainly sold through specialty distributors. Approximately 70% of 50,000 tons produced annually are sold in Milorganite 40-pound and 50-pound bags. MMSD pays a contractor for bagging service.

Milorganite's success can be attributed to consistency in their product and customer service. MMSD continues to ensure that their distributors profit from selling the Milorganite products with product promotions, territory protection and inventory control. Milorganite is a mature fertilizer product and marketing efforts have been mainly in the area of market share maintenance. Until recently all the Milorganite that could be produced could be sold. Increasing competition in bulk HDBF has put pressure on the Milorganite market. In 1994 the price of Milorganite fell from $141/ton to $106/ton as MMSD sold off excess inventory. In 1996 MMSD estimated the sales price to be $102/ton with a marketing and packaging cost of $66/ton (Net revenue of $36/ton average).

Milorganite is expected to continue to focus on the bagged HDBF market where it has yet to see a significant HDBF competitive challenge. In this market Milorganite competes with the aggressive fertilizer companies like Scotts®. In Milwaukee, Milorganite's hometown, Scotts has 39% of the market compared to Milorganite's 13%.

New York City, NY
Annual Production 80,000 tons
Facility owned and operated by New York Organic Fertilizer Company (NYOFCO) a Wheelabrator (WMX) company.
Biosolids Marketing by Bio-Grow (WMX company)
Product Analysis: 5% Nitrogen, 3% Phosphate 0% Potassium.

NYOFCO under a contract with the New York City Department of Environmental Protection (NYCDEP) constructed, operates and disposes of the HDBF from this heat drying facility. If the product is sold, for more than the freight charges, then the NYCDEP receives 50% (less freight adjustment) of the revenues. This is the largest HDBF facility in the country producing 220 tons of fertilizer per day since 8/93. The product has been delivered to many states including Florida, Ohio, Maine, Texas, Colorado, Arkansas and Oklahoma. Approximately 280,000 tons have been produced since operation began generating a total of approximately $1.5 million to the NYCDEP ($5.36/ton average). These figures do not consider the costs to dispose of material not sold. In 1996, approximately 70% of the total production generated NYCDEP revenue. The costs to distribute the remaining 30% are not known.

Hagerstown, MD
Annual Production 2,000 tons
Facility owned by City of Hagerstown
Facility operated by (WMX) company.
Biosolids Marketing by Bio-Grow (WMX company)
Product Analysis: 5% Nitrogen, 3% Phosphate 0% Potassium.

This small facility produces 2000 tons per year. About half of the production is sold for approximately $20/ton the remaining half is given away at no charge. The product is currently distributed to local agriculture. The City of Hagerstown has never subsidized the distribution or disposal of the product. Local farmers will gladly pickup the product when it is free and apply it to their fields even in the winter. The City receives 50% of revenues collected. The estimated revenue to the City is $10,000 annually or $5/ton average.

Tampa, FL
Annual Production 10,000 tons
Facility owned and operated by the City of Tampa
Biosolids Marketing by Vital-Cycle®
Product Analysis: 6% Nitrogen, 3% Phosphate 0% Potassium.

The City of Tampa has been producing approximately 10,000 tons of HDBF annually since 1991. The vast majority of the Tampa product has been sold to fertilizer blenders in its home state, Florida. The Florida market is very familiar with the benefits of HDBF. The year round growing season and low freight costs brought the Tampa product price to $120/ton in the early 1990's. The advantages of the Florida market attracted the new large HDBF producers (e.g. NYOFCO) in 1993 and by 1995 the Tampa price had plummeted to $42/ton.

The City of Tampa hired Vital-Cycle® 4-1-95 to market the HDBF. Vital-Cycle® installed a product quality improvement system. The current Tampa product price is $52.50/ton the City receives 65% ($34.13/ton). Approximately 20% of the annual production has been sold at a discount to alleviate storage problems.

Houston, TX
Annual Production 20,000 quality product, 20,000 tons of fines
Facility owned and operated by the City of Houston
Biosolids Marketing by Vital-Cycle®
Product Analysis: 6% Nitrogen, 3% Phosphate 0% Potassium.

The City of Houston (COH) has been in HDBF since the 1920's. Currently producing HDBF at two facilities. In 1994 Vital-Cycle® installed a quality improvement system and began marketing the HDBF for the COH. Two products are produced. 1) A quality product (Hou-Actinite®) that is granular and free of dust is sold to Specialty Blenders. 2) The fines, is a dusty product that is sold directly to local agriculture.

Hou-Actinite® is currently sold in several states across the country. It is a very high quality product selling for as much as $100/ton (freight included). The Hou-Actinite® price has increased from $25/ton in 1994 to the current average price of approximately $35/ton (freight excluded). The City of Houston receives 50% of the revenues or approximately $17.50/ton.

In 1996 Vital-Cycle® began to market the COH HDBF fines within a 60-mile radius of the facility. In this situation Vital-Cycle® is an Agri-Service Dealer. The product is sold, delivered and applied by Vital-Cycle®. The product is charged to the customer at $15/ton (freight and application fees not included). The City of Houston receives 50% or $7.50/ton. Not all of the fines are sold in this manner about 30% are sold for $3/ton to $5/ton to avoid disposal costs. Prior to 1996 the fines were sent to a landfill at a cost to the City of Houston.

Waco, TX
Annual Production 4000 tons
Facility owned and operated by the Brazos River Authority
Biosolids Marketing by Vital-Cycle®
Product Analysis: 5% Nitrogen, 3% Phosphate 0% Potassium.

Waco has been producing a product since 1995. The Waco product is sold to Specialty Blenders and directly to agriculture. The vast majority of the product sells for $35/ton with the BRA receiving 50% of the revenue or $17.50/ton. Some of the product has been sold for $20/ton directly to agriculture when storage is unavailable. Since the start of production the entire Waco production has been sold. Because of the previous market development efforts with Hou-Actinite® Vital-Cycle® was able to sell the Waco product into the existing Texas HDBF market.

MCES Local HDBF Market Research

The local HDBF market potential is a key factor in determining the value of HDBF for MCES. The relative shorter hauling distance translates to lower delivered prices to the customer and higher margins for the producer. The local agriculture market is the likely target for a new HDBF because of the volumes that can be sold the shorter sales cycles and the reduced freight. To determine the MCES local agriculture market Steve Stark, MCES Soil Scientist, and Richard Kendall, President of Vital-Cycle®, met with three of the local Minnesota Extension Service County Extension Educators[iii] to explain HDBF and get their perspective of the marketability of a HDBF in their geographical areas of responsibility. These agriculture professionals work with local farmers on a daily basis and therefore their perceptions reflect the mindset of those agricultural communities. The highlights of those interviews are:

1. The Extension Educators (EEs) were familiar with the beneficial reuse of bio-solids and with Milwaukee's HDBF Milorganite®. They were supportive of a MCES HDBF facility from an environmental perspective if the HDBF was handled in a responsible manner. They sited MCES Eviro-Soil as an example of a well-managed biosolids reuse project.
2. The EEs acknowledged the chemical fertilizer values of HDBF. There was a concern that the cool soils of Minnesota would limit the nitrogen availability over a single growing season and that farmers may have to double application rates used on the warmer soils of the south. This slow-release characteristic was also recognized as potentially valuable to sandy soil areas. The lack of potash in HDBF was a concern to the EEs because it is used heavily in the area. The phosphorus in the HDBF was viewed as adding little value because local soils are high in that nutrient.
3. In discussing the organic values of HDBF, the EEs felt that some farmers might recognize these values but not to a large extent. The nitrogen content would determine the value of HDBF.
4. The primary fertilizers used in the area are concentrated chemical fertilizers including anhydrous ammonia, urea and ammonium nitrate. The farmers are getting expected results and there is no major dissatisfaction with the use of these products. A HDBF would need to compete with these products. One EE felt that $35/ton including delivery and application might be a reasonable price. Farmers may require a HDBF to be significantly less than the chemical products in order to try it on a large scale.
5. There are over 25,000,000 acres in agriculture in Minnesota[iv] representing a vast fertilizer market. Some of this land may be unavailable to HDBF. The EEs explained that some large farmers who are growing for the large produce canning companies might be reluctant to use a HDBF. Some of these companies have restrictions on bio-solids and it is not known how HDBF will be perceived. Pasturelands in the area, a typical HDBF market in the south, are often left unfertilized in Minnesota.
6. Large farmers would require application service but many smaller farmers would have pull type spreaders and may be able to apply the HDBF. The majority of fertilizer is applied in the spring. Much less is applied in the summer and fall. The EEs thought that fall application of HDBF would be considered and may offer some benefits.

For local fertilizer pricing information Richard Kendall interviewed Hiram Lund, of Eau-Claire Co-op, in Eau-Claire, Wisconsin. Table 3 summarizes the comparative fertilizer pricing information (MCES area including application). The value of HDBF is calculated for each chemical fertilizer value of nitrogen. The MCES high quality HDBF will have 110 pounds of nitrogen/ton (5.5% N per MCES product specification). The nitrogen content of the lower quality MCES HDBF product is estimated at 4.5% (90 pounds of nitrogen per ton)

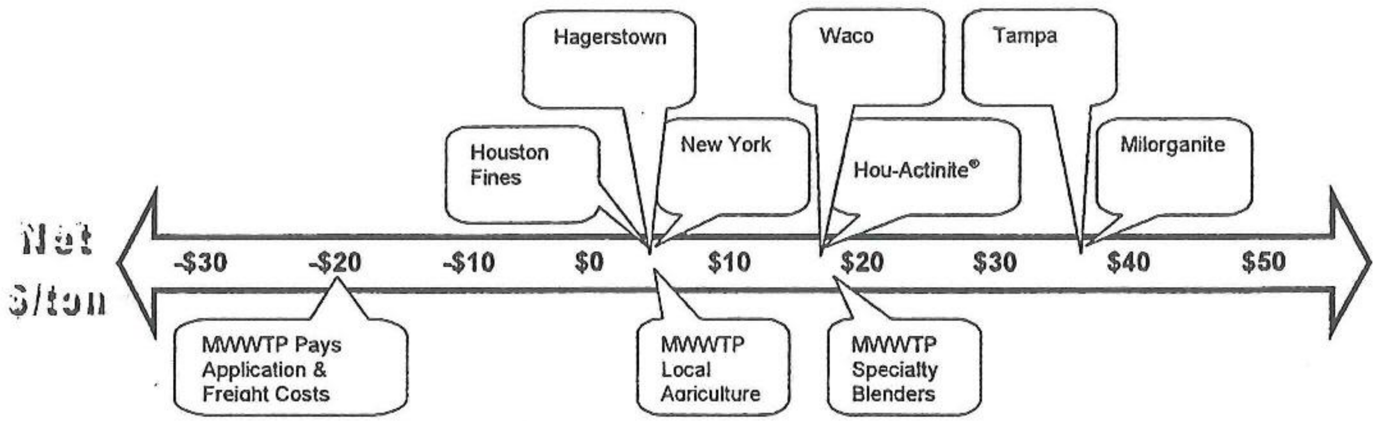
Table 3 Comparative Fertilizer Pricing

Chemical Fertilizer	Price to Farmer ($/LB-Nitrogen)	High Quality HDBF Value $/ton
Anhydrous Ammonia	$0.24	$26.40
Ammonium Nitrate	$0.28	$30.80
Urea	$0.30	$33.00

MCES HDBF Product Marketing Potential

Production specifications were defined by MCES to be; 5.5% nitrogen, 3% phosphorus, 0% potash; a annual production of a low dust, low odor quality product at 53,000/tons; or an annual production of a odorous, potentially dusty product at 92,000 tons with 4.5% nitrogen.

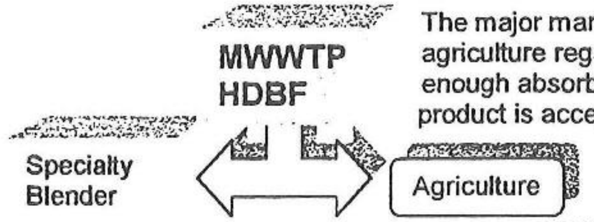
According to Kim Erickson of ChM2Hill: The primary sludge component of the high quality product is limited to thirty (30%) percent. Whereas, the lower quality product would incorporate all primary sludge (approximately sixty (60%) percent of the dried product) produced at the Metropolitan Wastewater Treatment Plant. Increasing the percentage of primary sludge in the product reduces the nitrogen concentration and increases product odors, fibers and dust. The high quality product alternative requires a separate process for stabilization and use of the resident primary sludge (108± dry tons per day in year 2005).



The chart above positions HDBF producers relative to the HDBF net revenue received (all marketing, transportation and application costs removed). Refer to the Specific Producers Information Section.

MMSD's Milorganite is the market leader because of their consistent product quality and decades of effort working directly with the Specialty Distributors. Considering the recent decreases in Milorganite pricing and additional competition it is unlikely that MCES or any other HDBF producers will reach this market position in the foreseeable future. Tampa, Houston and Waco have Milorganite level quality but not the Milorganite distribution. Tampa, Houston and Waco benefit from low freight to customers with extended growing seasons. Hagerstown and New York focus on agriculture and have a freight disadvantage. The Houston Fines are a very dusty product that can only be sold with application included. A MCES HDBF should have similar performance in similar markets as shown.

Suggested MCES HDBF Distribution



The major market focus for MCES HDBF will need to be on local agriculture regardless of product quality. The agriculture market is large enough absorb the 53,000 to 93,000 tons of annual production if the product is accepted and can be distributed and applied for the farmer. Selling this quantity of product will require a significant effort. This will require the creation of highly effective HDBF Agri-Service business to sell, deliver and apply the HDBF. The capital required for delivery and application equipment could exceed $1 million (recovered in freight and application fees). The Agri-Service business should be started well in advance of the production of product. HDBF field trials to explore the potential of fall, winter and saturated spring soil application should be conducted as soon as possible. Fall and winter application will probably be required to avoid excessive HDBF storage, transportation and disposal costs.

Early subsidizing of freight and application is likely (estimated MCES costs at $20/ton). If all goes very well within four years the MCES average revenue could be at approximately $5/ton. This assumes a $30/ton customer price less $20/ton for application and freight costs less $5/ton for marketing costs. Prices above this are possible but seem optimistic considering the price of chemical fertilizers (table 3) and the experience of other HDBF producers.

The quality MCES product can be sold to the Specialty Blender market. It will continue to be competitive with HDBF marketers competing for a fixed number of Specialty Blender customers. An aggressive growth goal for a MCES HDBF product in this market is 3000 tons/year of this market. Reasonable MCES revenue for this market is $17.50/ton, based on the experience of other HDBF producers.

The volume and prices projected here could vary widely. There are many factors that could affect the sale of a MCES HDBF product in the local agriculture market. It is highly recommended that HDBF be test marketed to local agriculture before investing capital in production facilities.

Factors affecting the long term success of a HDBF business strategy

- Local farmer acceptance of HDBF. A test market study should be completed to see if local agriculture would try HDBF.
- Product quality: Producing a quality product requires a fertilizer production mindset as opposed to a bio-solids disposal mindset. Quality criteria include nutrient content, sizing, dryness, odor, contaminants, and consistency. An odorous, dusty product is more difficult to market and may obtain a bad reputation in the industry.
  - Production equipment: Drying, handling and storage equipment must be selected considering the impact to product quality.
- Customer Service: Long term success is much more than marketing, as with any business, it requires a multitude of customer services and long term relationships with customer and vendors.
  - Make it easy for the customer to buy. Provide supplemental services, transportation, application, and education.
  - Supporting your customers marketing efforts: Managing inventory and transportation, delivering the product when it is needed.
- Market strategy: Pick the right targets and apply the required resources. Understand how that particular market benefits from the HDBF. Be flexible and quick to change when wrong.
- Misuse of product: Inappropriate application can have a devastating effect on the product reputation and future sales. Inappropriate storage can cause fire, property damage and serious odor complaints from entire communities.

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[i] The Nature and Properties of Soils, Nyle C. Brady and Ray R. Weil, Prentice Hall 1996
[ii] Fertilizer Technology and Use, O.P. Englestadt, Soil Science of America, Inc. 1985
[iii] Robert P. Olson, Extension Educator and Professor, Dakota County; G. Lee Raeth, Educator and Professor, Wright County; Rodney Elmstrand, Community Research Specialist, Chisago County.
[iv] 1995 Minnesota Extension Service Agriculture Profile.

MCES CAPITAL IMPROVEMENTS ALTERNATIVES ANALYSIS
ANALYSIS PARAMETERS

LIFE CYCLE COST SUMMARY

No.	Title	Capital Cost	O&M Cost	Present Worth	EAC
1	Four Fluid Bed Incinerators	214,581,000	9,999,000	299,540,167	17,368,000
2	Three Fluid Bed Incinerators w/ Alkaline Stabilization	188,720,000	10,267,000	283,293,531	16,426,000
3	Heat-Drying - Low Nitrogen Product	263,344,000	11,838,000	350,902,175	20,346,000
4	Heat Drying - High Nitrogen Product	263,191,000	10,489,000	335,082,791	19,429,000
5	Anaerobic Digestion w/ Cake Storage	253,872,000	11,738,000	343,966,515	19,944,000
6	Full Alkaline Stabilization	220,654,000	11,392,000	317,745,543	18,424,000

ECONOMIC PARAMETERS

Item	Value	Source/Comment
Base Year	1998	Common for all alternatives.
Commence Construction	2002	Default--adjusted for some alternatives, where noted.
Begin Operation	2005	Default--adjusted for some alternatives, where noted.
Planning Period End	2025	Common for all alternatives. Revised assumption for this analysis.
Inflation Rate	3.0%	Based on MCES planning guidelines.
Discount Rate	6.0%	Based on MCES planning guidelines.
Undeveloped Design Details	25%	Based on MCES facility planning guidelines.
Engrg, Admin, Training, Legal & Contingency	25%	Based on MCES facility planning guidelines.
Replacement Cost Factor	1.5	Assumes some customizing and installation.
Dried-Product Revenues		
Low-Nitrogen Average Revenues ($ per Ton)	5.00	Refer to Dried Product Market Analysis, net of marketing costs.
High Quality Average Revenues ($ per Ton)	7.83	Refer to Dried Product Market Analysis, net of marketing costs.
Market Development Period (Years)	n/a	Not used.
Secondary Revenue Inflation Factor (%)	n/a	Not used.
Marketing Cost ($ per Ton)	n/a	Assumes 4 year market pre-development period.
Marketing Cost Offset Period (years)	n/a	Not used.
Hauling of Dried Product, $ per Dry Ton	n/a	Not used.
Land Applic. of Dried Product, $ per Dry Ton	n/a	Not used.
Ash Disposal Cost		
Cost per Ton	53.00	Based on 1998 MCES contract rate.
Secondary Cost Inflation Factor (%)	n/a	Not used.

OPERATIONS & MAINTENANCE

Category	Unit	Unit Cost	Alt	Source/Comment
Labor (Operations)	FTE	$ 68,500.00	all	Program 3900 (Operations), 1998 Budget
Utilities				
Natural Gas	MBTU	$ 3.07	all	Master Plan estimate.
Electricity	KwHrs	$ 0.0458	all	Master Plan estimate.
Electricity Credit	KwHrs	$ 0.025	all	Not used.
Electric Demand Credit	KwHrs	n/a	all	Not used.
Fuel Oil	Gal	$ 0.65	all	Master Plan estimate.
Chemicals				
Polymer	lbs	$ 2.25	all	Master Plan estimate.
Chlorine	Tons	$ 0.1285	Dry	Master Plan estimate.
SO2	Tons	$ 0.14	Dry	Master Plan estimate.
Boiler Feed Chemicals	LS	$ 30,000.00	all	Master Plan estimate.
End-Product Disposal				
Land Application of Alk. Stab. Product	Tons	$ 12.35	FBI	Master Plan estimate.
Land Application of Digested Product	Tons	$ 20.00	Anaer. Digest.	
Ash Disposal	Tons	$ 53.00	FBI	Current contract rate.
Landfill Disposal of Grit/Screenings	Tons	$ 10.00	Dry	Master Plan estimate.
CKD	Tons	$ 23.00	all	Master Plan estimate.
Maintenance				
Labor	FTE	$ 54,500.00	all	Program 4000 (Operations), 1998 Budget
Materials	LS	3.00%	all	Percent of Equipment Cost

Appendix F

MCES SOLIDS PROCESS IMPROVEMENTS PROJECT

LIFE-CYCLE COST ANALYSIS

1 Four Fluid Bed Incinerators

CAPITAL COSTS

Type	Item	1998 Cost	Year of Expenditure	Year in Operation	Drawdown Year 1	Drawdown Year 2	Drawdown Year 3	Drawdown Year 4	Escalated Cost	Present Worth
Demolition	F&I1 to Grade	-	2006	2006	100%	0%	0%	0%	-	-
Demolition	Pole Building	-	2002	2005	100%	0%	0%	0%	-	-
Structure	Foundation	5,994,000	2002	2005	30%	50%	20%	0%	6,930,000	5,208,000
Structure	Concrete	12,537,000	2002	2005	30%	50%	20%	0%	14,494,000	10,894,000
Structure	Metals	1,519,000	2002	2005	30%	50%	20%	0%	1,756,000	1,320,000
Structure	Paint/Waterproofing	650,000	2002	2005	30%	50%	20%	0%	751,000	565,000
Structure	Incinerator Building	38,500,000	2002	2005	30%	50%	20%	0%	44,510,000	33,454,000
Structure	Electrical Service Duct Bank	1,300,000	2002	2005	30%	50%	20%	0%	1,503,000	1,130,000
Structure	Tunnel	400,000	2002	2005	30%	50%	20%	0%	462,000	348,000
Structure	Loadin/Loadout Building	360,000	2002	2005	30%	50%	20%	0%	416,000	313,000
Structure	Lime Silo	-	2002	2005	30%	50%	20%	0%	-	-
Equipment	Fluid Bed Incinerators	15,600,000	2002	2005	0%	80%	20%	0%	18,193,000	13,437,000
Equipment	Wet ESPs	3,800,000	2002	2005	0%	80%	20%	0%	4,432,000	3,273,000
Equipment	Multiple Cyclones	1,800,000	2002	2005	0%	80%	20%	0%	2,099,000	1,550,000
Equipment	Waste Heat Boilers	2,600,000	2002	2005	0%	80%	20%	0%	3,032,000	2,240,000
Equipment	Venturi Scrubbers	980,000	2002	2005	0%	80%	20%	0%	1,143,000	844,000
Equipment	Tray Cooling towers	1,100,000	2002	2005	0%	80%	20%	0%	1,283,000	948,000
Equipment	ID Fans	1,000,000	2002	2005	0%	80%	20%	0%	1,166,000	861,000
Equipment	Steam System	2,500,000	2002	2005	0%	80%	20%	0%	2,916,000	2,153,000
Equipment	Sludge Feed Pumps	4,480,000	2002	2005	0%	80%	20%	0%	5,225,000	3,859,000
Equipment	Bed Extraction System	1,200,000	2002	2005	0%	80%	20%	0%	1,399,000	1,034,000
Equipment	Combustion Air Heat Exchanger	2,040,000	2002	2005	0%	80%	20%	0%	2,379,000	1,757,000
Equipment	Reheat Heat Exchanger	1,800,000	2002	2005	0%	80%	20%	0%	2,099,000	1,550,000
Equipment	Turbine Building	3,690,000	2002	2005	0%	80%	20%	0%	4,303,000	3,178,000
Equipment	Ash Handling System	1,500,000	2002	2005	0%	80%	20%	0%	1,749,000	1,292,000
Equipment	CEMS	629,000	2002	2005	0%	80%	20%	0%	734,000	542,000
Equipment	Centrifuges	8,400,000	2002	2005	0%	80%	20%	0%	9,796,000	7,236,000
Equipment	Centrifuge Feed Pumps	800,000	2002	2005	0%	80%	20%	0%	933,000	689,000
Equipment	Relocate and Rehab Centrifuges	150,000	2002	2005	0%	80%	20%	0%	175,000	129,000
Equipment	Ash Silos Mechanical Systems	2,250,000	2002	2005	0%	80%	20%	0%	2,624,000	1,938,000
Equipment	Lime Silo Mechanical Systems	-	2002	2005	0%	80%	20%	0%	-	-
Equipment	Dewatered Sludge Convey/Loadout	2,500,000	2002	2005	0%	80%	20%	0%	2,916,000	2,153,000
Equipment	Pug Mills	-	2002	2005	0%	80%	20%	0%	-	-
Equipment	Mechanical Piping and Conveyance	5,200,000	2002	2005	0%	80%	20%	0%	6,064,000	4,479,000
Equipment	Odor Control	1,000,000	2002	2005	0%	80%	20%	0%	1,166,000	861,000
Equipment	Electrical (10% of Equipment)	6,502,000	2002	2005	0%	80%	20%	0%	7,583,000	5,601,000
Equipment	I&C (7% of Equipment)	4,551,000	2002	2005	0%	80%	20%	0%	5,308,000	3,920,000
TOTAL CONSTRUCTION COST		137,332,000							159,539,000	118,756,000
Undeveloped Design Details (25%)		34,333,000	2002	2005				n/a	39,885,000	26,526,000
Engr'g, Admin, Training, Legal & Contingency (25%)		42,916,000	2002	2005				n/a	49,856,000	33,157,000
TOTAL PROJECT COST		214,581,000	2002	2005					249,280,000	178,439,000

MCES SOLIDS PROCESS IMPROVEMENTS PROJECT
LIFE-CYCLE COST ANALYSIS
1 Four Fluid Bed Incinerators

REPLACEMENT COSTS

Type	Item	Useful Life	Replacement First	Second	Third	Fourth	Fifth	Escalated Cost (First)	Present Worth
Structure	Foundation	50	0	0	0	0	0	-	-
Structure	Concrete	50	0	0	0	0	0	-	-
Structure	Metals	50	0	0	0	0	0	-	-
Structure	Paint/Waterproofing	50	0	0	0	0	0	-	-
Structure	Incinerator Building	50	0	0	0	0	0	-	-
Structure	Electrical Service Duct Bank	50	0	0	0	0	0	-	-
Structure	Tunnel	50	0	0	0	0	0	-	-
Structure	Loadin/Loadout Building	50	0	0	0	0	0	-	-
Structure	Lime Silo	50	0	0	0	0	0	-	-
Equipment	Fluid Bed Incinerators	25	0	0	0	0	0	-	-
Equipment	Wet ESPs	15	2020	0	0	0	0	10,922,000	3,031,000
Equipment	Multiple Cyclones	15	2020	0	0	0	0	5,173,000	1,436,000
Equipment	Waste Heat Boilers	20	0	0	0	0	0	-	-
Equipment	Venturi Scrubbers	20	0	0	0	0	0	-	-
Equipment	Tray Cooling towers	20	0	0	0	0	0	-	-
Equipment	ID Fans	15	2020	0	0	0	0	2,874,000	798,000
Equipment	Steam System	20	0	0	0	0	0	-	-
Equipment	Sludge Feed Pumps	15	2020	0	0	0	0	12,876,000	3,573,000
Equipment	Bed Extraction System	20	0	0	0	0	0	-	-
Equipment	Combustion Air Heat Exchanger	15	2020	0	0	0	0	5,863,000	1,627,000
Equipment	Reheat Heat Exchanger	15	2020	0	0	0	0	5,173,000	1,436,000
Equipment	Turbine Building	20	0	0	0	0	0	-	-
Equipment	Ash Handling System	20	0	0	0	0	0	-	-
Equipment	CEMS	20	0	0	0	0	0	-	-
Equipment	Centrifuges	20	0	0	0	0	0	-	-
Equipment	Centrifuge Feed Pumps	15	2020	0	0	0	0	2,299,000	638,000
Equipment	Relocate and Rehab Centrifuges	15	2020	0	0	0	0	431,000	120,000
Equipment	Ash Silos Mechanical Systems	15	2020	0	0	0	0	6,467,000	1,795,000
Equipment	Lime Silo Mechanical Systems	15	2020	0	0	0	0	-	-
Equipment	Dewatered Sludge Convey/Loadout	15	2020	0	0	0	0	7,185,000	1,994,000
Equipment	Pug Mills	15	2020	0	0	0	0	-	-
Equipment	Mechanical Piping and Conveyance	20	0	0	0	0	0	-	-
Equipment	Odor Control	15	2020	0	0	0	0	2,874,000	798,000
Equipment	Electrical (10% of Equipment)	15	2020	0	0	0	0	18,688,000	5,186,000
Equipment	I&C (7% of Equipment)	15	2020	0	0	0	0	13,080,000	3,630,000
TOTAL								93,905,000	26,062,000

MCES SOLIDS PROCESS IMPROVEMENTS PROJECT
LIFE-CYCLE COST ANALYSIS
1 Four Fluid Bed Incinerators

TERMINAL VALUES

Type	Item	Useful Life (Years)	Useful Life at End of Planning Period	Escalated Terminal Value	Present Worth
Structure	Foundation	50	30	(7,989,000)	(1,657,000)
Structure	Concrete	50	30	(16,709,000)	(3,465,000)
Structure	Metals	50	30	(2,024,000)	(420,000)
Structure	Paint/Waterproofing	50	30	(866,000)	(180,000)
Structure	Incinerator Building	50	30	(51,312,000)	(10,640,000)
Structure	Electrical Service Duct Bank	50	30	(1,733,000)	(359,000)
Structure	Tunnel	50	30	(533,000)	(111,000)
Structure	Loadin/Loadout Building	50	30	(480,000)	(100,000)
Structure	Lime Silo	50	30	-	-
Equipment	Fluid Bed Incinerators	25	5	(6,930,000)	(1,437,000)
Equipment	Wet ESPs	15	10	(5,627,000)	(1,167,000)
Equipment	Multiple Cyclones	15	10	(2,666,000)	(553,000)
Equipment	Waste Heat Boilers	20	0	-	-
Equipment	Venturi Scrubbers	20	0	-	-
Equipment	Tray Cooling towers	20	0	-	-
Equipment	ID Fans	15	10	(1,481,000)	(307,000)
Equipment	Steam System	20	0	-	-
Equipment	Sludge Feed Pumps	15	10	(6,634,000)	(1,376,000)
Equipment	Bed Extraction System	20	0	-	-
Equipment	Combustion Air Heat Exchanger	15	10	(3,021,000)	(626,000)
Equipment	Reheat Heat Exchanger	15	10	(2,666,000)	(553,000)
Equipment	Turbine Building	20	0	-	-
Equipment	Ash Handling System	20	0	-	-
Equipment	CEMS	20	0	-	-
Equipment	Centrifuges	20	0	-	-
Equipment	Centrifuge Feed Pumps	15	10	(1,185,000)	(246,000)
Equipment	Relocate and Rehab Centrifuges	15	10	(222,000)	(46,000)
Equipment	Ash Silos Mechanical Systems	15	10	(3,332,000)	(691,000)
Equipment	Lime Silo Mechanical Systems	15	10	-	-
Equipment	Dewatered Sludge Convey/Loadout	15	10	(3,702,000)	(768,000)
Equipment	Pug Mills	15	10	-	-
Equipment	Mechanical Piping and Conveyance	20	0	-	-
Equipment	Odor Control	15	10	(1,481,000)	(307,000)
Equipment	Electrical (10% of Equipment)	15	10	(9,629,000)	(1,997,000)
Equipment	I&C (7% of Equipment)	15	10	(6,739,000)	(1,397,000)
TOTAL				(136,961,000)	(28,403,000)

MCES SOLIDS PROCESS IMPROVEMENTS PROJECT
LIFE-CYCLE COST ANALYSIS
1 Four Fluid Bed Incinerators

O&M COSTS

Units	Item	Present Annual Cost	Escalated Annual Cost	Present Worth
2005 - 2025 Estimated O&M Costs		1998	2005	
44	FTE Labor	3,014,000	3,707,000	
36,500	MBTU of Natural Gas	112,000	138,000	
32,698,981	KwHrs of Electrictity	1,498,000	1,842,000	
-	land application alk stab	-	-	
-	tons of ckd	-	-	
791,320	pounds of polymer	1,780,000	2,189,000	
-	electrical credit @$.025/kwhr	-	-	
-	electric demand credit	-	-	
0	gals of fuel oil	-	-	
	maintenance-materials	2,282,000	2,807,000	
	chemicals for boiler feed water	30,000	37,000	
TOTAL		8,716,000	10,720,000	107,602,865

USPW Factor 13.2105

(USPW refers to uniform stream present worth factor, 6 percent over 32 years, from 1998 to 2025)

END-PRODUCT USES

Units	Item	Present Annual Cost	Escalated Annual Cost	Present Worth	Present Worth
		1998	2005		
24,205	Ash Disposal (Tons per Year)	1,283,000	1,578,000		15,839,302

LIFE CYCLE COSTS

TOTAL PRESENT WORTH	299,540,167
TOTAL EQUIVALENT ANNUAL COST	22,674,000

MCES SOLIDS PROCESS IMPROVEMENTS PROJECT
LIFE-CYCLE COST ANALYSIS
2 Three Fluid Bed Incinerators w/ Alkaline Stabilization

CAPITAL COSTS

Type	Item	1998 Cost	Year of Expenditure	Year in Operation	Drawdown Year 1	Drawdown Year 2	Drawdown Year 3	Drawdown Year 4	Escalated Cost	Present Worth
Demolition	F&I1 to Grade	-	2006	2006	100%	0%	0%	0%	-	-
Demolition	Pole Building	-	2002	2005	100%	0%	0%	0%	-	-
Structure	Foundation	4,620,000	2002	2005	30%	50%	20%	0%	5,341,000	4,015,000
Structure	Concrete	10,344,000	2002	2005	30%	50%	20%	0%	11,959,000	8,988,000
Structure	Metals	1,197,000	2002	2005	30%	50%	20%	0%	1,384,000	1,040,000
Structure	Paint/Waterproofing	583,000	2002	2005	30%	50%	20%	0%	674,000	507,000
Structure	Incinerator Building	29,750,000	2002	2005	30%	50%	20%	0%	34,394,000	25,851,000
Structure	Electrical Service Duct Bank	1,300,000	2002	2005	30%	50%	20%	0%	1,503,000	1,130,000
Structure	Tunnel	400,000	2002	2005	30%	50%	20%	0%	462,000	348,000
Structure	Alkaline Loadout Building	720,000	2002	2005	30%	50%	20%	0%	832,000	626,000
Structure	Lime Silo	3,600,000	2002	2005	30%	50%	20%	0%	4,162,000	3,128,000
Equipment	Fluid Bed Incinerators	11,700,000	2002	2005	0%	80%	20%	0%	13,645,000	10,078,000
Equipment	Wet ESPs	2,850,000	2002	2005	0%	80%	20%	0%	3,324,000	2,455,000
Equipment	Multiple Cyclones	1,350,000	2002	2005	0%	80%	20%	0%	1,574,000	1,163,000
Equipment	Waste Heat Boilers	1,950,000	2002	2005	0%	80%	20%	0%	2,274,000	1,680,000
Equipment	Venturi Scrubbers	735,000	2002	2005	0%	80%	20%	0%	857,000	633,000
Equipment	Tray Cooling towers	825,000	2002	2005	0%	80%	20%	0%	962,000	711,000
Equipment	ID Fans	750,000	2002	2005	0%	80%	20%	0%	875,000	646,000
Equipment	Steam System	1,875,000	2002	2005	0%	80%	20%	0%	2,187,000	1,615,000
Equipment	Sludge Feed Pumps	3,360,000	2002	2005	0%	80%	20%	0%	3,919,000	2,894,000
Equipment	Bed Extraction System	900,000	2002	2005	0%	80%	20%	0%	1,050,000	775,000
Equipment	Combustion Air Heat Exchanger	1,530,000	2002	2005	0%	80%	20%	0%	1,784,000	1,318,000
Equipment	Reheat Heat Exchanger	1,350,000	2002	2005	0%	80%	20%	0%	1,574,000	1,163,000
Equipment	Turbine Building	3,690,000	2002	2005	0%	80%	20%	0%	4,303,000	3,178,000
Equipment	Ash Handling System	1,500,000	2002	2005	0%	80%	20%	0%	1,749,000	1,292,000
Equipment	CEMS	480,000	2002	2005	0%	80%	20%	0%	560,000	413,000
Equipment	Centrifuges	8,400,000	2002	2005	0%	80%	20%	0%	9,796,000	7,236,000
Equipment	Centrifuge Feed Pumps	800,000	2002	2005	0%	80%	20%	0%	933,000	689,000
Equipment	Relocate and Rehab Centrifuges	150,000	2002	2005	0%	80%	20%	0%	175,000	129,000
Equipment	Ash Silos Mechanical Systems	2,250,000	2002	2005	0%	80%	20%	0%	2,624,000	1,938,000
Equipment	Lime Silo Mechanical Systems	900,000	2002	2005	0%	80%	20%	0%	1,050,000	775,000
Equipment	Alkaline Conveyance/Loadout	4,000,000	2002	2005	0%	80%	20%	0%	4,665,000	3,445,000
Equipment	Pug Mills	303,000	2002	2005	0%	80%	20%	0%	353,000	261,000
Equipment	Mechanical Piping and Conveyance	5,200,000	2002	2005	0%	80%	20%	0%	6,064,000	4,479,000
Equipment	Odor Control	1,500,000	2002	2005	0%	80%	20%	0%	1,749,000	1,292,000
Equipment	Electrical (10% of Equipment)	5,835,000	2002	2005	0%	80%	20%	0%	6,805,000	5,026,000
Equipment	I&C (7% of Equipment)	4,084,000	2002	2005	0%	80%	20%	0%	4,763,000	3,518,000
TOTAL CONSTRUCTION COST		120,781,000							140,325,000	104,435,000
Undeveloped Design Details (25%)		30,195,000	2002	2005				n/a	35,081,000	23,331,000
Engr'g, Admin,Training,Legal & Contingency (25%)		37,744,000	2002	2005				n/a	43,852,000	29,164,000
TOTAL PROJECT COST		188,720,000	2002	2005					219,258,000	156,930,000

MCES SOLIDS PROCESS IMPROVEMENTS PROJECT
LIFE-CYCLE COST ANALYSIS
2 Three Fluid Bed Incinerators w/ Alkaline Stabilization

REPLACEMENT COSTS

Type	Item	Useful Life	Replacement First	Second	Third	Fourth	Fifth	Escalated Cost (First)	Present Worth
Structure	Foundation	50	0	0	0	0	0	-	-
Structure	Concrete	50	0	0	0	0	0	-	-
Structure	Metals	50	0	0	0	0	0	-	-
Structure	Paint/Waterproofing	50	0	0	0	0	0	-	-
Structure	Incinerator Building	50	0	0	0	0	0	-	-
Structure	Electrical Service Duct Bank	50	0	0	0	0	0	-	-
Structure	Tunnel	50	0	0	0	0	0	-	-
Structure	Alkaline Loadout Building	50	0	0	0	0	0	-	-
Structure	Lime Silo	50	0	0	0	0	0	-	-
Equipment	Fluid Bed Incinerators	25	0	0	0	0	0	-	-
Equipment	Wet ESPs	15	2020	0	0	0	0	8,191,000	2,273,000
Equipment	Multiple Cyclones	15	2020	0	0	0	0	3,880,000	1,077,000
Equipment	Waste Heat Boilers	20	0	0	0	0	0	-	-
Equipment	Venturi Scrubbers	20	0	0	0	0	0	-	-
Equipment	Tray Cooling towers	20	0	0	0	0	0	-	-
Equipment	ID Fans	15	2020	0	0	0	0	2,156,000	598,000
Equipment	Steam System	20	0	0	0	0	0	-	-
Equipment	Sludge Feed Pumps	15	2020	0	0	0	0	9,657,000	2,680,000
Equipment	Bed Extraction System	20	0	0	0	0	0	-	-
Equipment	Combustion Air Heat Exchanger	15	2020	0	0	0	0	4,397,000	1,220,000
Equipment	Reheat Heat Exchanger	15	2020	0	0	0	0	3,880,000	1,077,000
Equipment	Turbine Building	20	0	0	0	0	0	-	-
Equipment	Ash Handling System	20	0	0	0	0	0	-	-
Equipment	CEMS	20	0	0	0	0	0	-	-
Equipment	Centrifuges	20	0	0	0	0	0	-	-
Equipment	Centrifuge Feed Pumps	15	2020	0	0	0	0	2,299,000	638,000
Equipment	Relocate and Rehab Centrifuges	15	2020	0	0	0	0	431,000	120,000
Equipment	Ash Silos Mechanical Systems	15	2020	0	0	0	0	6,467,000	1,795,000
Equipment	Lime Silo Mechanical Systems	15	2020	0	0	0	0	2,587,000	718,000
Equipment	Alkaline Conveyance/Loadout	15	2020	0	0	0	0	11,497,000	3,190,000
Equipment	Pug Mills	15	2020	0	0	0	0	871,000	242,000
Equipment	Mechanical Piping and Conveyance	20	0	0	0	0	0	-	-
Equipment	Odor Control	15	2020	0	0	0	0	4,311,000	1,196,000
Equipment	Electrical (10% of Equipment)	15	2020	0	0	0	0	16,771,000	4,654,000
Equipment	I&C (7% of Equipment)	15	2020	0	0	0	0	11,738,000	3,257,000
TOTAL								89,133,000	24,735,000

MCES SOLIDS PROCESS IMPROVEMENTS PROJECT
LIFE-CYCLE COST ANALYSIS
2 Three Fluid Bed Incinerators w/ Alkaline Stabilization

TERMINAL VALUES

Type	Item	Useful Life (Years)	Useful Life at End of Planning Period	Escalated Terminal Value	Present Worth
Structure	Foundation	50	30	(6,157,000)	(1,277,000)
Structure	Concrete	50	30	(13,786,000)	(2,859,000)
Structure	Metals	50	30	(1,595,000)	(331,000)
Structure	Paint/Waterproofing	50	30	(777,000)	(161,000)
Structure	Incinerator Building	50	30	(39,650,000)	(8,222,000)
Structure	Electrical Service Duct Bank	50	30	(1,733,000)	(359,000)
Structure	Tunnel	50	30	(533,000)	(111,000)
Structure	Alkaline Loadout Building	50	30	(960,000)	(199,000)
Structure	Lime Silo	50	30	(4,798,000)	(995,000)
Equipment	Fluid Bed Incinerators	25	5	(5,198,000)	(1,078,000)
Equipment	Wet ESPs	15	10	(4,220,000)	(875,000)
Equipment	Multiple Cyclones	15	10	(1,999,000)	(415,000)
Equipment	Waste Heat Boilers	20	0	-	-
Equipment	Venturi Scrubbers	20	0	-	-
Equipment	Tray Cooling towers	20	0	-	-
Equipment	ID Fans	15	10	(1,111,000)	(230,000)
Equipment	Steam System	20	0	-	-
Equipment	Sludge Feed Pumps	15	10	(4,976,000)	(1,032,000)
Equipment	Bed Extraction System	20	0	-	-
Equipment	Combustion Air Heat Exchanger	15	10	(2,266,000)	(470,000)
Equipment	Reheat Heat Exchanger	15	10	(1,999,000)	(415,000)
Equipment	Turbine Building	20	0	-	-
Equipment	Ash Handling System	20	0	-	-
Equipment	CEMS	20	0	-	-
Equipment	Centrifuges	20	0	-	-
Equipment	Centrifuge Feed Pumps	15	10	(1,185,000)	(246,000)
Equipment	Relocate and Rehab Centrifuges	15	10	(222,000)	(46,000)
Equipment	Ash Silos Mechanical Systems	15	10	(3,332,000)	(691,000)
Equipment	Lime Silo Mechanical Systems	15	10	(1,333,000)	(276,000)
Equipment	Alkaline Conveyance/Loadout	15	10	(5,923,000)	(1,228,000)
Equipment	Pug Mills	15	10	(449,000)	(93,000)
Equipment	Mechanical Piping and Conveyance	20	0	-	-
Equipment	Odor Control	15	10	(2,221,000)	(461,000)
Equipment	Electrical (10% of Equipment)	15	10	(8,641,000)	(1,792,000)
Equipment	I&C (7% of Equipment)	15	10	(6,048,000)	(1,254,000)
TOTAL				(121,112,000)	(25,116,000)

MCES SOLIDS PROCESS IMPROVEMENTS PROJECT
LIFE-CYCLE COST ANALYSIS
2 Three Fluid Bed Incinerators w/ Alkaline Stabilization

O&M COSTS

Units	Item	Present Annual Cost	Escalated Annual Cost	Present Worth
2005 - 2025 Estimated O&M Cost		1998	2005	
44	FTE Labor	3,014,000	3,707,000	
36,500	MBTU of Natural Gas	112,000	138,000	
32,698,981	KwHrs of Electrictity	1,498,000	1,842,000	
33,570	land application alk stab	415,000	510,000	
8,370	tons of ckd	193,000	237,000	
791,320	pounds of polymer	1,780,000	2,189,000	
-	electrical credit @$.025/kwhr	-	-	
-	electric demand credit	-	-	
-	gals of fuel oil	-	-	
	maintenance-materials	2,048,000	2,519,000	
	chemicals for boiler feed water	30,000	37,000	
TOTAL		9,090,000	11,179,000	112,210,114

USPW Factor 13.2105 (USPW refers to uniform stream present worth factor, 6 percent over 32 years, from 1998 to 2025)

END-PRODUCT USES

Units	Item	Present Annual Cost	Escalated Annual Cost	Present Worth	Present Worth
		1998	2005		
22,216	Ash Disposal (Tons per Year)	1,177,000	1,448,000		14,534,417

LIFE CYCLE COSTS

TOTAL PRESENT WORTH	283,293,531
TOTAL EQUIVALENT ANNUAL COST	21,445,000

MCES SOLIDS PROCESS IMPROVEMENTS PROJECT
LIFE-CYCLE COST ANALYSIS
3 Heat Drying - High Nitrogen Product

CAPITAL COSTS

Type	Item	1998 Cost	Year of Expenditure	Year in Operation	Drawdown Year 1	Drawdown Year 2	Drawdown Year 3	Drawdown Year 4	Escalated Cost	Present Worth
Demolition	F&I1 to Grade	-	2006	2006	100%	0%	0%	0%	-	-
Demolition	Pole Building	-	2002	2005	100%	0%	0%	0%	-	-
Structure	Foundation	3,524,000	2002	2005	30%	50%	20%	0%	4,074,000	3,062,000
Structure	Concrete	7,686,000	2002	2005	30%	50%	20%	0%	8,886,000	6,679,000
Structure	Metals	1,027,000	2002	2005	30%	50%	20%	0%	1,187,000	892,000
Structure	Paint/Waterproofing	841,000	2002	2005	30%	50%	20%	0%	972,000	731,000
Structure	Dryer Building	20,412,000	2002	2005	30%	50%	20%	0%	23,598,000	17,737,000
Structure	Electrical Duct Bank	1,300,000	2002	2005	30%	50%	20%	0%	1,503,000	1,130,000
Structure	Tunnels	400,000	2002	2005	30%	50%	20%	0%	462,000	348,000
Structure	Dried Product Silos	32,400,000	2002	2005	30%	50%	20%	0%	37,458,000	28,154,000
Structure	Lime Silo	1,800,000	2002	2005	30%	50%	20%	0%	2,081,000	1,564,000
Structure	Alkaline Truck Loadout	720,000	2002	2005	30%	50%	20%	0%	832,000	626,000
Equipment	Dryer Trains w/ APCs	45,000,000	2002	2005	0%	80%	20%	0%	52,480,000	38,762,000
Equipment	Centrifuges incl Polymer	8,400,000	2002	2005	0%	80%	20%	0%	9,796,000	7,236,000
Equipment	Move & Refurbish One Centrifuge	150,000	2002	2005	0%	80%	20%	0%	175,000	129,000
Equipment	Centrifuge Feed Pumps	800,000	2002	2005	0%	80%	20%	0%	933,000	689,000
Equipment	Boilers for Plant Heating	2,250,000	2002	2005	0%	80%	20%	0%	2,624,000	1,938,000
Equipment	Dry Product Handling System	4,000,000	2002	2005	0%	80%	20%	0%	4,665,000	3,445,000
Equipment	Process Piping	5,300,000	2002	2005	0%	80%	20%	0%	6,181,000	4,565,000
Equipment	Product Silo Mechanical Systems	8,100,000	2002	2005	0%	80%	20%	0%	9,446,000	6,977,000
Equipment	Lime Silo Mechanical Systems	450,000	2002	2005	0%	80%	20%	0%	525,000	388,000
Equipment	Alkaline Conveyance/Loadout	4,000,000	2002	2005	0%	80%	20%	0%	4,665,000	3,445,000
Equipment	Pug Mill Mixer	202,000	2002	2005	0%	80%	20%	0%	236,000	174,000
Equipment	Odor Control	1,000,000	2002	2005	0%	80%	20%	0%	1,166,000	861,000
Equipment	Product Screens	1,782,000	2002	2005	0%	80%	20%	0%	2,078,000	1,535,000
Equipment	Product Rollers	732,000	2002	2005	0%	80%	20%	0%	854,000	631,000
Equipment	Product Bins	162,000	2002	2005	0%	80%	20%	0%	189,000	140,000
Equipment	Product Coolers	1,800,000	2002	2005	0%	80%	20%	0%	2,099,000	1,550,000
Equipment	Electrical (10% of Equipment)	8,413,000	2002	2005	0%	80%	20%	0%	9,811,000	7,247,000
Equipment	I&C (7% of Equipment)	5,889,000	2002	2005	0%	80%	20%	0%	6,868,000	5,073,000
TOTAL CONSTRUCTION COST		168,540,000							195,844,000	145,708,000
Undeveloped Design Details (25%)		42,135,000	2002	2005				n/a	48,961,000	32,562,000
Engr'g, Admin,Training,Legal & Contingency (25%)		52,669,000	2002	2005				n/a	61,201,000	40,702,000
TOTAL PROJECT COST		263,344,000	2002	2005					306,006,000	218,972,000

MCES SOLIDS PROCESS IMPROVEMENTS PROJECT
LIFE-CYCLE COST ANALYSIS
3 Heat Drying - High Nitrogen Product

REPLACEMENT COSTS

Type	Item	Useful Life	Replacement First	Second	Third	Fourth	Fifth	Escalated Cost (First)	Present Worth
Structure	Foundation	50	0	0	0	0	0	-	-
Structure	Concrete	50	0	0	0	0	0	-	-
Structure	Metals	50	0	0	0	0	0	-	-
Structure	Paint/Waterproofing	50	0	0	0	0	0	-	-
Structure	Dryer Building	50	0	0	0	0	0	-	-
Structure	Electrical Duct Bank	50	0	0	0	0	0	-	-
Structure	Tunnels	50	0	0	0	0	0	-	-
Structure	Dried Product Silos	50	0	0	0	0	0	-	-
Structure	Lime Silo	50	0	0	0	0	0	-	-
Structure	Alkaline Truck Loadout	50	0	0	0	0	0	-	-
Equipment	Dryer Trains w/ APCs	25	0	0	0	0	0	-	-
Equipment	Centrifuges incl Polymer	20	0	0	0	0	0	-	-
Equipment	Move & Refurbish One Centrifuge	15	2020	0	0	0	0	431,000	120,000
Equipment	Centrifuge Feed Pumps	15	2020	0	0	0	0	2,299,000	638,000
Equipment	Boilers for Plant Heating	20	0	0	0	0	0	-	-
Equipment	Dry Product Handling System	20	0	0	0	0	0	-	-
Equipment	Process Piping	20	0	0	0	0	0	-	-
Equipment	Product Silo Mechanical Systems	20	0	0	0	0	0	-	-
Equipment	Lime Silo Mechanical Systems	20	0	0	0	0	0	-	-
Equipment	Alkaline Conveyance/Loadout	20	0	0	0	0	0	-	-
Equipment	Pug Mill Mixer	15	2020	0	0	0	0	581,000	161,000
Equipment	Odor Control	15	2020	0	0	0	0	2,874,000	798,000
Equipment	Product Screens	15	2020	0	0	0	0	5,122,000	1,421,000
Equipment	Product Rollers	15	2020	0	0	0	0	2,104,000	584,000
Equipment	Product Bins	20	0	0	0	0	0	-	-
Equipment	Product Coolers	20	0	0	0	0	0	-	-
Equipment	Electrical (10% of Equipment)	15	2020	0	0	0	0	24,180,000	6,710,000
Equipment	I&C (7% of Equipment)	15	2020	0	0	0	0	16,926,000	4,697,000
TOTAL								54,517,000	15,129,000

MCES SOLIDS PROCESS IMPROVEMENTS PROJECT
LIFE-CYCLE COST ANALYSIS
3 Heat Drying - High Nitrogen Product

TERMINAL VALUES

Type	Item	Useful Life (Years)	Useful Life at End of Planning Period	Escalated Terminal Value	Present Worth
Structure	Foundation	50	30	(4,697,000)	(974,000)
Structure	Concrete	50	30	(10,244,000)	(2,124,000)
Structure	Metals	50	30	(1,369,000)	(284,000)
Structure	Paint/Waterproofing	50	30	(1,121,000)	(232,000)
Structure	Dryer Building	50	30	(27,205,000)	(5,641,000)
Structure	Electrical Duct Bank	50	30	(1,733,000)	(359,000)
Structure	Tunnels	50	30	(533,000)	(111,000)
Structure	Dried Product Silos	50	30	(43,182,000)	(8,955,000)
Structure	Lime Silo	50	30	(2,399,000)	(497,000)
Structure	Alkaline Truck Loadout	50	30	(960,000)	(199,000)
Equipment	Dryer Trains w/ APCs	25	5	(19,992,000)	(4,146,000)
Equipment	Centrifuges incl Polymer	20	0	-	-
Equipment	Move & Refurbish One Centrifuge	15	10	(222,000)	(46,000)
Equipment	Centrifuge Feed Pumps	15	10	(1,185,000)	(246,000)
Equipment	Boilers for Plant Heating	20	0	-	-
Equipment	Dry Product Handling System	20	0	-	-
Equipment	Process Piping	20	0	-	-
Equipment	Product Silo Mechanical Systems	20	0	-	-
Equipment	Lime Silo Mechanical Systems	20	0	-	-
Equipment	Alkaline Conveyance/Loadout	20	0	-	-
Equipment	Pug Mill Mixer	15	10	(299,000)	(62,000)
Equipment	Odor Control	15	10	(1,481,000)	(307,000)
Equipment	Product Screens	15	10	(2,639,000)	(547,000)
Equipment	Product Rollers	15	10	(1,084,000)	(225,000)
Equipment	Product Bins	20	0	-	-
Equipment	Product Coolers	20	0	-	-
Equipment	Electrical (10% of Equipment)	15	10	(12,458,000)	(2,583,000)
Equipment	I&C (7% of Equipment)	15	10	(8,721,000)	(1,808,000)
TOTAL				(141,524,000)	(29,346,000)

MCES SOLIDS PROCESS IMPROVEMENTS PROJECT
LIFE-CYCLE COST ANALYSIS
3 Heat Drying - High Nitrogen Product

O&M COSTS

Units	Item	Present Annual Cost	Escalated Annual Cost	Present Worth
2005 - 2025 Estimated O&M Costs		1998	2005	
54	FTE Labor	3,699,000	4,549,000	
642,638	MBTU of Natural Gas	1,973,000	2,427,000	
41,192,550	KwHrs of Electricity	1,887,000	2,321,000	
-	land application alk stab	-	-	
-	tons of ckd	-	-	
791,300	pounds of polymer	1,780,000	2,189,000	
-	electrical credit @$.025/kwhr	-	-	
-	electric demand credit	-	-	
-	gals of fuel oil	-	-	
	maintenance-materials	2,953,000	3,632,000	
	chemicals for boiler feed water	30,000	37,000	
TOTAL		12,322,000	15,155,000	152,119,535

USPW Factor 13.2105 (USPW refers to uniform stream present worth factor, 6 percent over 32 years, from 1998 to 2025)

END-PRODUCT USES

Units	Item	Present Annual Cost	Escalated Annual	Present Worth	Present Worth
		1998	2005		
96,725	Dried Product to Market	(484,000)	(595,000)		(5,972,361)

LIFE CYCLE COSTS

TOTAL PRESENT WORTH	350,902,175
TOTAL EQUIVALENT ANNUAL COST	26,562,000

MCES SOLIDS PROCESS IMPROVEMENTS PROJECT
LIFE-CYCLE COST ANALYSIS
4 Heat Drying - High Nitrogen Product

CAPITAL COSTS

Type	Item	1998 Cost	Year of Expenditure	Year in Operation	Drawdown Year 1	Year 2	Year 3	Year 4	Escalated Cost	Present Worth
Demolition	F&I1 to Grade	-	2006	2006	100%	0%	0%	0%	-	-
Demolition	Pole Building	-	2002	2005	100%	0%	0%	0%	-	-
Structure	Foundation	12,140,000	2002	2005	30%	50%	20%	0%	14,035,000	10,549,000
Structure	Concrete	34,078,000	2002	2005	30%	50%	20%	0%	39,398,000	29,612,000
Structure	Metals	1,066,000	2002	2005	30%	50%	20%	0%	1,232,000	926,000
Structure	Paint/Waterproofing	708,000	2002	2005	30%	50%	20%	0%	819,000	615,000
Structure	Dryer Building	13,608,000	2002	2005	30%	50%	20%	0%	15,732,000	11,825,000
Structure	Electrical Duct Bank	1,300,000	2002	2005	30%	50%	20%	0%	1,503,000	1,130,000
Structure	Tunnels	4,720,000	2002	2005	30%	50%	20%	0%	5,457,000	4,101,000
Structure	Dried Product Silos	18,000,000	2002	2005	30%	50%	20%	0%	20,810,000	15,641,000
Structure	Lime Silo	-	2002	2005	30%	50%	20%	0%	-	-
Structure	Alkaline Silo	-	2002	2005	30%	50%	20%	0%	-	-
Equipment	Dryer Trains w/ APCs	30,000,000	2002	2005	0%	80%	20%	0%	34,987,000	25,841,000
Equipment	Centrifuges incl Polymer	6,000,000	2002	2005	0%	80%	20%	0%	6,997,000	5,168,000
Equipment	Move & Refurbish One Centrifuge	150,000	2002	2005	0%	80%	20%	0%	175,000	129,000
Equipment	Centrifuge Feed Pumps	600,000	2002	2005	0%	80%	20%	0%	700,000	517,000
Equipment	Boilers for Plant Heating	2,250,000	2002	2005	0%	80%	20%	0%	2,624,000	1,938,000
Equipment	Boilers for Digester Heating	2,250,000	2002	2005	0%	80%	20%	0%	2,624,000	1,938,000
Equipment	Dry Product Handling System	1,500,000	2002	2005	0%	80%	20%	0%	1,749,000	1,292,000
Equipment	Process Piping	7,400,000	2002	2005	0%	80%	20%	0%	8,630,000	6,374,000
Equipment	Product Silo Mechanical Systems	4,500,000	2002	2005	0%	80%	20%	0%	5,248,000	3,876,000
Equipment	Odor Control	1,500,000	2002	2005	0%	80%	20%	0%	1,749,000	1,292,000
Equipment	Product Screens	1,188,000	2002	2005	0%	80%	20%	0%	1,385,000	1,023,000
Equipment	Product Rollers	488,000	2002	2005	0%	80%	20%	0%	569,000	420,000
Equipment	Product Bins	108,000	2002	2005	0%	80%	20%	0%	126,000	93,000
Equipment	Product Coolers	1,200,000	2002	2005	0%	80%	20%	0%	1,399,000	1,034,000
Equipment	Digester Heat Exchanger	357,000	2002	2005	0%	80%	20%	0%	416,000	308,000
Equipment	Digester Mixing Equipment	4,364,000	2002	2005	0%	80%	20%	0%	5,089,000	3,759,000
Equipment	Waste Gas Incinerator	1,316,000	2002	2005	0%	80%	20%	0%	1,535,000	1,134,000
Equipment	Digester Train Transfer Pump	322,000	2002	2005	0%	80%	20%	0%	376,000	277,000
Equipment	Digester Recirulation Pumps	250,000	2002	2005	0%	80%	20%	0%	292,000	215,000
Equipment	Digester Hot Water Recirc Pumps	120,000	2002	2005	0%	80%	20%	0%	140,000	103,000
Equipment	Thickening Centrifuges w/ Polymer	3,600,000	2002	2005	0%	80%	20%	0%	4,198,000	3,101,000
Equipment	Thickening Centrifuge Feed Pumps	400,000	2002	2005	0%	80%	20%	0%	466,000	345,000
Equipment	Thickened Sludge Pumps	300,000	2002	2005	0%	80%	20%	0%	350,000	258,000
Equipment	Truck Loading Pumps	625,000	2002	2005	0%	80%	20%	0%	729,000	538,000
Equipment	Electrical (10% of Equipment)	7,079,000	2002	2005	0%	80%	20%	0%	8,256,000	6,098,000
Equipment	I&C (7% of Equipment)	4,955,000	2002	2005	0%	80%	20%	0%	5,779,000	4,268,000
TOTAL CONSTRUCTION COST		168,442,000							195,574,000	145,738,000
Undeveloped Design Details (25%)		42,111,000	2002	2005				n/a	48,893,500	32,517,000
Engr'g, Admin,Training,Legal & Contingency (25%)		52,638,000	2002	2005				n/a	61,117,000	40,646,000
TOTAL PROJECT COST		263,191,000	2002	2005					305,584,500	218,901,000

MCES SOLIDS PROCESS IMPROVEMENTS PROJECT
LIFE-CYCLE COST ANALYSIS
4 Heat Drying - High Nitrogen Product

REPLACEMENT COSTS

Type	Item	Useful Life	Replacement First	Second	Third	Fourth	Fifth	Escalated Cost (First)	Present Worth
Structure	Foundation	50	0	0	0	0	0	-	-
Structure	Concrete	50	0	0	0	0	0	-	-
Structure	Metals	50	0	0	0	0	0	-	-
Structure	Paint/Waterproofing	50	0	0	0	0	0	-	-
Structure	Dryer Building	50	0	0	0	0	0	-	-
Structure	Electrical Duct Bank	50	0	0	0	0	0	-	-
Structure	Tunnels	50	0	0	0	0	0	-	-
Structure	Dried Product Silos	50	0	0	0	0	0	-	-
Structure	Lime Silo	50	0	0	0	0	0	-	-
Structure	Alkaline Silo	50	0	0	0	0	0	-	-
Equipment	Dryer Trains w/ APCs	25	0	0	0	0	0	-	-
Equipment	Centrifuges incl Polymer	20	0	0	0	0	0	-	-
Equipment	Move & Refurbish One Centrifuge	15	2020	0	0	0	0	431,000	120,000
Equipment	Centrifuge Feed Pumps	15	2020	0	0	0	0	1,724,000	479,000
Equipment	Boilers for Plant Heating	20	0	0	0	0	0	-	-
Equipment	Boilers for Digester Heating	20	0	0	0	0	0	-	-
Equipment	Dry Product Handling System	20	0	0	0	0	0	-	-
Equipment	Process Piping	20	0	0	0	0	0	-	-
Equipment	Product Silo Mechanical Systems	20	0	0	0	0	0	-	-
Equipment	Odor Control	15	2020	0	0	0	0	4,311,000	1,196,000
Equipment	Product Screens	15	2020	0	0	0	0	3,414,000	948,000
Equipment	Product Rollers	15	2020	0	0	0	0	1,403,000	389,000
Equipment	Product Bins	20	0	0	0	0	0	-	-
Equipment	Product Coolers	20	0	0	0	0	0	-	-
Equipment	Digester Heat Exchanger	20	0	0	0	0	0	-	-
Equipment	Digester Mixing Equipment	15	2020	0	0	0	0	12,543,000	3,481,000
Equipment	Waste Gas Incinerator	15	2020	0	0	0	0	3,782,000	1,050,000
Equipment	Digester Train Transfer Pump	15	2020	0	0	0	0	925,000	257,000
Equipment	Digester Recirulation Pumps	15	2020	0	0	0	0	719,000	199,000
Equipment	Digester Hot Water Recirc Pumps	15	2020	0	0	0	0	345,000	96,000
Equipment	Thickening Centrifuges w/ Polymer	20	0	0	0	0	0	-	-
Equipment	Thickening Centrifuge Feed Pumps	15	2020	0	0	0	0	1,150,000	319,000
Equipment	Thickened Sludge Pumps	15	2020	0	0	0	0	862,000	239,000
Equipment	Truck Loading Pumps	15	2020	0	0	0	0	1,796,000	498,000
Equipment	Electrical (10% of Equipment)	15	2020	0	0	0	0	20,346,000	5,646,000
Equipment	I&C (7% of Equipment)	15	2020	0	0	0	0	14,241,000	3,952,000
TOTAL								67,992,000	18,869,000

MCES SOLIDS PROCESS IMPROVEMENTS PROJECT
LIFE-CYCLE COST ANALYSIS
4 Heat Drying - High Nitrogen Product

TERMINAL VALUES

Type	Item	Useful Life (Years)	Useful Life at End of Planning Period	Escalated Terminal Value	Present Worth
Structure	Foundation	50	30	(16,180,000)	(3,355,000)
Structure	Concrete	50	30	(45,418,000)	(9,418,000)
Structure	Metals	50	30	(1,421,000)	(295,000)
Structure	Paint/Waterproofing	50	30	(944,000)	(196,000)
Structure	Dryer Building	50	30	(18,136,000)	(3,761,000)
Structure	Electrical Duct Bank	50	30	(1,733,000)	(359,000)
Structure	Tunnels	50	30	(6,291,000)	(1,305,000)
Structure	Dried Product Silos	50	30	(23,990,000)	(4,975,000)
Structure	Lime Silo	50	30	-	-
Structure	Alkaline Silo	50	30	-	-
Equipment	Dryer Trains w/ APCs	25	5	(13,328,000)	(2,764,000)
Equipment	Centrifuges incl Polymer	20	0	-	-
Equipment	Move & Refurbish One Centrifuge	15	10	(222,000)	(46,000)
Equipment	Centrifuge Feed Pumps	15	10	(889,000)	(184,000)
Equipment	Boilers for Plant Heating	20	0	-	-
Equipment	Boilers for Digester Heating	20	0	-	-
Equipment	Dry Product Handling System	20	0	-	-
Equipment	Process Piping	20	0	-	-
Equipment	Product Silo Mechanical Systems	20	0	-	-
Equipment	Odor Control	15	10	(2,221,000)	(461,000)
Equipment	Product Screens	15	10	(1,759,000)	(365,000)
Equipment	Product Rollers	15	10	(723,000)	(150,000)
Equipment	Product Bins	20	0	-	-
Equipment	Product Coolers	20	0	-	-
Equipment	Digester Heat Exchanger	20	0	-	-
Equipment	Digester Mixing Equipment	15	10	(6,462,000)	(1,340,000)
Equipment	Waste Gas Incinerator	15	10	(1,949,000)	(404,000)
Equipment	Digester Train Transfer Pump	15	10	(477,000)	(99,000)
Equipment	Digester Recirulation Pumps	15	10	(370,000)	(77,000)
Equipment	Digester Hot Water Recirc Pumps	15	10	(178,000)	(37,000)
Equipment	Thickening Centrifuges w/ Polymer	20	0	-	-
Equipment	Thickening Centrifuge Feed Pumps	15	10	(592,000)	(123,000)
Equipment	Thickened Sludge Pumps	15	10	(444,000)	(92,000)
Equipment	Truck Loading Pumps	15	10	(926,000)	(192,000)
Equipment	Electrical (10% of Equipment)	15	10	(10,483,000)	(2,174,000)
TOTAL				(155,136,000)	(32,172,000)

MCES SOLIDS PROCESS IMPROVEMENTS PROJECT
LIFE-CYCLE COST ANALYSIS
4 Heat Drying - High Nitrogen Product

O&M COSTS

Units	Item	Present Annual Cost	Escalated Annual Cost	Present Worth
2005 - 2025	Estimated O&M Costs	1998	2005	
60	FTE Labor	4,110,000	5,055,000	
137,000	MBTU of Natural Gas	421,000	518,000	
33,557,000	KwHrs of Electrictity	1,537,000	1,890,000	
23,360	land application alk stab	288,000	354,000	
-	tons of ckd	-	-	
911,040	pounds of polymer	2,050,000	2,521,000	
-	electrical credit @$.025/kwhr	-	-	
-	electric demand credit	-	-	
-	gals of fuel oil	-	-	
	maintenance-materials	2,485,000	3,056,000	
	chemicals for boiler feed water	30,000	37,000	
TOTAL		10,921,000	13,431,000	134,814,746

USPW Factor 13.2105 (USPW refers to uniform stream present worth factor, 6 percent over 32 years, from 1998 to 2025)

END-PRODUCT USES

Units	Item	Present Annual Cost	Escalated Annual	Present Worth	Present Worth
		1998	2005		
55,225	Dried Product to Market	(432,000)	(531,000)		(5,329,955)

LIFE CYCLE COSTS

TOTAL PRESENT WORTH	335,082,791
TOTAL EQUIVALENT ANNUAL COST	25,365,000

MCES SOLIDS PROCESS IMPROVEMENTS PROJECT
LIFE-CYCLE COST ANALYSIS
5 **Anaerobic Digestion w/ Cake Storage**

CAPITAL COSTS

Type	Item	1998 Cost	Year of Expenditure	Year in Operation	Drawdown Year 1	Drawdown Year 2	Drawdown Year 3	Drawdown Year 4	Escalated Cost	Present Worth
Demolition	F&I1 to Grade	-	2006	2006	100%	0%	0%	0%	-	-
Demolition	Pole Building	-	2002	2005	100%	0%	0%	0%	-	-
Structure	Foundation	17,103,000	2002	2005	30%	50%	20%	0%	19,773,000	14,862,000
Structure	Concrete	45,791,000	2002	2005	30%	50%	20%	0%	52,939,000	39,790,000
Structure	Metals	7,522,000	2002	2005	30%	50%	20%	0%	8,696,000	6,536,000
Structure	Paint/Waterproofing	535,000	2002	2005	30%	50%	20%	0%	619,000	465,000
Structure	Electrical Duct Bank	1,300,000	2002	2005	30%	50%	20%	0%	1,503,000	1,130,000
Structure	Tunnels	3,200,000	2002	2005	30%	50%	20%	0%	3,700,000	2,781,000
Structure	Roof over Cake Storage	20,869,000	2002	2005	30%	50%	20%	0%	24,127,000	18,134,000
Structure	Dewatering Facility in Cake Storage	3,500,000	2002	2005	30%	50%	20%	0%	4,046,000	3,041,000
Structure		-	2002	2005	30%	50%	20%	0%	-	-
Structure		-	2002	2005	30%	50%	20%	0%	-	-
Equipment	Move and Refurb One Centrifuge	150,000	2002	2005	0%	80%	20%	0%	175,000	129,000
Equipment	Centrifuge Feed Pumps	800,000	2002	2005	0%	80%	20%	0%	933,000	689,000
Equipment	Dewatering Centrif for Cake Storage	7,200,000	2002	2005	0%	80%	20%	0%	8,397,000	6,202,000
Equipment	Boilers for Plant Heating	2,250,000	2002	2005	0%	80%	20%	0%	2,624,000	1,938,000
Equipment	Boilers for Digester Heating	2,250,000	2002	2005	0%	80%	20%	0%	2,624,000	1,938,000
Equipment	Process Piping	7,000,000	2002	2005	0%	80%	20%	0%	8,164,000	6,030,000
Equipment	Odor Control	3,200,000	2002	2005	0%	80%	20%	0%	3,732,000	2,756,000
Equipment	Digester Heat Exchanger	428,000	2002	2005	0%	80%	20%	0%	499,000	369,000
Equipment	Digester Mixing Equipment	9,000,000	2002	2005	0%	80%	20%	0%	10,496,000	7,752,000
Equipment	Waste Gas Incinerator	2,632,000	2002	2005	0%	80%	20%	0%	3,070,000	2,267,000
Equipment	Digester Train Transfer Pump	129,000	2002	2005	0%	80%	20%	0%	150,000	111,000
Equipment	Digester Recirulation Pumps	300,000	2002	2005	0%	80%	20%	0%	350,000	258,000
Equipment	Digester Hot Water Recirc Pumps	120,000	2002	2005	0%	80%	20%	0%	140,000	103,000
Equipment	Cake Screw conveyor to Bins	2,100,000	2002	2005	0%	80%	20%	0%	2,449,000	1,809,000
Equipment	Cake Screw Conveyor w/ Bins	15,750,000	2002	2005	0%	80%	20%	0%	18,368,000	13,567,000
Equipment	Truck Loading System	240,000	2002	2005	0%	80%	20%	0%	280,000	207,000
Equipment		-	2002	2005	0%	80%	20%	0%	-	-
Equipment		-	2002	2005	0%	80%	20%	0%	-	-
Equipment		-	2002	2005	0%	80%	20%	0%	-	-
Equipment		-	2002	2005	0%	80%	20%	0%	-	-
Equipment		-	2002	2005	0%	80%	20%	0%	-	-
Equipment		-	2002	2005	0%	80%	20%	0%	-	-
Equipment		-	2002	2005	0%	80%	20%	0%	-	-
Equipment		-	2002	2005	0%	80%	20%	0%	-	-
Equipment	Electrical (10% of Equipment)	5,355,000	2002	2005	0%	80%	20%	0%	6,245,000	4,613,000
Equipment	I&C (7% of Equipment)	3,748,000	2002	2005	0%	80%	20%	0%	4,371,000	3,228,000
TOTAL CONSTRUCTION COST		162,472,000							188,470,000	140,705,000
Undeveloped Design Details (25%)		40,600,000	2002	2005				n/a	47,117,500	31,336,000
Engr'g, Admin,Training,Legal & Contingency (25%)		50,800,000	2002	2005				n/a	58,897,000	39,170,000
TOTAL PROJECT COST		253,872,000	2002	2005					294,484,500	211,211,000

MCES SOLIDS PROCESS IMPROVEMENTS PROJECT

LIFE-CYCLE COST ANALYSIS

5 Anaerobic Digestion w/ Cake Storage

REPLACEMENT COSTS

Type	Item		Useful Life	Replacement First	Second	Third	Fourth	Fifth	Escalated Cost (First)	Present Worth
Structure	Foundation		50	0	0	0	0	0	-	-
Structure	Concrete		50	0	0	0	0	0	-	-
Structure	Metals		50	0	0	0	0	0	-	-
Structure	Paint/Waterproofing		50	0	0	0	0	0	-	-
Structure	Electrical Duct Bank		50	0	0	0	0	0	-	-
Structure	Tunnels		50	0	0	0	0	0	-	-
Structure	Roof over Cake Storage		50	0	0	0	0	0	-	-
Structure	Dewatering Facility in Cake Storage		50	0	0	0	0	0	-	-
Structure		0	50	0	0	0	0	0	-	-
Structure		0	50	0	0	0	0	0	-	-
Equipment	Move and Refurb One Centrifuge		20	0	0	0	0	0	-	-
Equipment	Centrifuge Feed Pumps		20	0	0	0	0	0	-	-
Equipment	Dewatering Centrif for Cake Storage		20	0	0	0	0	0	-	-
Equipment	Boilers for Plant Heating		15	2020	0	0	0	0	6,467,000	1,795,000
Equipment	Boilers for Digester Heating		20	0	0	0	0	0	-	-
Equipment	Process Piping		20	0	0	0	0	0	-	-
Equipment	Odor Control		15	2020	0	0	0	0	9,197,000	2,552,000
Equipment	Digester Heat Exchanger		15	2020	0	0	0	0	1,230,000	341,000
Equipment	Digester Mixing Equipment		15	2020	0	0	0	0	25,867,000	7,178,000
Equipment	Waste Gas Incinerator		15	2020	0	0	0	0	7,565,000	2,099,000
Equipment	Digester Train Transfer Pump		20	0	0	0	0	0	-	-
Equipment	Digester Recirulation Pumps		15	2020	0	0	0	0	862,000	239,000
Equipment	Digester Hot Water Recirc Pumps		15	2020	0	0	0	0	345,000	96,000
Equipment	Cake Screw conveyor to Bins		15	2020	0	0	0	0	6,036,000	1,675,000
Equipment	Cake Screw Conveyor w/ Bins		20	0	0	0	0	0	-	-
Equipment	Truck Loading System		20	0	0	0	0	0	-	-
Equipment		0	20	0	0	0	0	0	-	-
Equipment		0	20	0	0	0	0	0	-	-
Equipment		0	20	0	0	0	0	0	-	-
Equipment		0	20	0	0	0	0	0	-	-
Equipment		0	20	0	0	0	0	0	-	-
Equipment		0	20	0	0	0	0	0	-	-
Equipment		0	20	0	0	0	0	0	-	-
Equipment		0	20	0	0	0	0	0	-	-
Equipment	Electrical (10% of Equipment)		15	2020	0	0	0	0	15,391,000	4,271,000
Equipment	I&C (7% of Equipment)		15	2020	0	0	0	0	10,772,000	2,989,000
TOTAL									83,732,000	23,235,000

MCES SOLIDS PROCESS IMPROVEMENTS PROJECT
LIFE-CYCLE COST ANALYSIS
5 **Anaerobic Digestion w/ Cake Storage**

TERMINAL VALUES

Type	Item		Useful Life (Years)	Useful Life at End of Planning Period	Escalated Terminal Value	Present Worth
Structure	Foundation		50	30	(22,794,000)	(4,727,000)
Structure	Concrete		50	30	(61,029,000)	(12,655,000)
Structure	Metals		50	30	(10,025,000)	(2,079,000)
Structure	Paint/Waterproofing		50	30	(713,000)	(148,000)
Structure	Electrical Duct Bank		50	30	(1,733,000)	(359,000)
Structure	Tunnels		50	30	(4,265,000)	(884,000)
Structure	Roof over Cake Storage		50	30	(27,814,000)	(5,768,000)
Structure	Dewatering Facility in Cake Storage		50	30	(4,665,000)	(967,000)
Structure		0	50	30	-	-
Structure		0	50	30	-	-
Equipment	Move and Refurb One Centrifuge		20	0	-	-
Equipment	Centrifuge Feed Pumps		20	0	-	-
Equipment	Dewatering Centrif for Cake Storage		20	0	-	-
Equipment	Boilers for Plant Heating		15	10	(3,332,000)	(691,000)
Equipment	Boilers for Digester Heating		20	0	-	-
Equipment	Process Piping		20	0	-	-
Equipment	Odor Control		15	10	(4,739,000)	(983,000)
Equipment	Digester Heat Exchanger		15	10	(634,000)	(131,000)
Equipment	Digester Mixing Equipment		15	10	(13,328,000)	(2,764,000)
Equipment	Waste Gas Incinerator		15	10	(3,898,000)	(808,000)
Equipment	Digester Train Transfer Pump		20	0	-	-
Equipment	Digester Recirulation Pumps		15	10	(444,000)	(92,000)
Equipment	Digester Hot Water Recirc Pumps		15	10	(178,000)	(37,000)
Equipment	Cake Screw conveyor to Bins		15	10	(3,110,000)	(645,000)
Equipment	Cake Screw Conveyor w/ Bins		20	0	-	-
Equipment	Truck Loading System		20	0	-	-
Equipment		0	20	0	-	-
Equipment		0	20	0	-	-
Equipment		0	20	0	-	-
Equipment		0	20	0	-	-
Equipment		0	20	0	-	-
Equipment		0	20	0	-	-
Equipment		0	20	0	-	-
Equipment		0	20	0	-	-
Equipment	Electrical (10% of Equipment)		15	10	(7,930,000)	(1,644,000)
TOTAL					(170,631,000)	(35,382,000)

MCES SOLIDS PROCESS IMPROVEMENTS PROJECT
LIFE-CYCLE COST ANALYSIS
5 Anaerobic Digestion w/ Cake Storage

O&M COSTS

Units	Item	Present Annual Cost	Escalated Annual Cost	Present Worth
2005 - 2025 Estimated O&M Costs		1998	2005	
32	FTE Labor	2,192,000	2,696,000	
-	MBTU of Natural Gas	-	-	
25,732,200	KwHrs of Electrictity	1,179,000	1,450,000	
209,200	Land Application of Digested Solids	4,184,000	5,146,000	
-	tons of ckd	-	-	
978,930	pounds of polymer	2,203,000	2,709,000	
-	electrical credit @$.025/kwhr	-	-	
-	electric demand credit	-	-	
-	gals of fuel oil	-	-	
	maintenance-materials	1,880,000	2,312,000	
	Odor Control Chemicals	100,000	123,000	
TOTAL		11,738,000	14,436,000	144,902,515

USPW Factor 13.2105 (USPW refers to uniform stream present worth factor, 6 percent over 32 years, from 1998 to 2025)

END-PRODUCT USES

Units	Item	Present Annual Cost	Escalated Annual	Present Worth	Present Worth
		1998	2005		
	- N/A	-	-		0

LIFE CYCLE COSTS

TOTAL PRESENT WORTH	343,966,515
TOTAL EQUIVALENT ANNUAL COST	26,037,000

MCES SOLIDS PROCESS IMPROVEMENTS PROJECT

LIFE-CYCLE COST ANALYSIS

6 Full Alkaline Stabilization

CAPITAL COSTS

Type	Item	1998 Cost	Year of Expenditure	Year in Operation	Drawdown Year 1	Year 2	Year 3	Year 4	Escalated Cost	Present Worth
Demolition	F&I1 to Grade	-	2006	2006	100%	0%	0%	0%	-	-
Demolition	Pole Building	-	2002	2005	100%	0%	0%	0%	-	-
Structure	Foundation	16,378,000	2002	2005	30%	50%	20%	0%	18,935,000	14,232,000
Structure	Concrete	17,877,000	2002	2005	30%	50%	20%	0%	20,668,000	15,534,000
Structure	Metals	6,163,000	2002	2005	30%	50%	20%	0%	7,125,000	5,355,000
Structure	Paint/Waterproofing	437,000	2002	2005	30%	50%	20%	0%	505,000	380,000
Structure	Electrical Duct Bank	1,300,000	2002	2005	30%	50%	20%	0%	1,503,000	1,130,000
Structure	Tunnels	1,600,000	2002	2005	30%	50%	20%	0%	1,850,000	1,390,000
Structure	Kiln Dust Storage Silos	3,600,000	2002	2005	30%	50%	20%	0%	4,162,000	3,128,000
Structure	Dewatering/Alkaline Mixing	3,360,000	2002	2005	30%	50%	20%	0%	3,884,000	2,920,000
Structure	Drying	8,960,000	2002	2005	30%	50%	20%	0%	10,359,000	7,786,000
Structure	Alkaline Product Storage	21,962,000	2002	2005	30%	50%	20%	0%	25,390,000	19,084,000
Structure	Odor Control / Chemical Storage	8,470,000	2002	2005	0%	80%	20%	0%	9,878,000	7,296,000
		-	2002	2005	0%	80%	20%	0%	-	-
Equipment	Move and Refurbish One Centrifuge	150,000	2002	2005	0%	80%	20%	0%	175,000	129,000
Equipment	Centrifuge Feed Pumps	800,000	2002	2005	0%	80%	20%	0%	933,000	689,000
Equipment	Dewatering Centrifuges for Cake St	7,200,000	2002	2005	0%	80%	20%	0%	8,397,000	6,202,000
Equipment	Boilers for Plant Heating	2,250,000	2002	2005	0%	80%	20%	0%	2,624,000	1,938,000
Equipment	Process Piping	5,200,000	2002	2005	0%	80%	20%	0%	6,064,000	4,479,000
Equipment	Odor Control Dryer Exhaust w/ WetV	3,200,000	2002	2005	0%	80%	20%	0%	3,732,000	2,756,000
Equipment	Odor Control Storage	6,000,000	2002	2005	0%	80%	20%	0%	6,997,000	5,168,000
Equipment	Mixers	1,200,000	2002	2005	0%	80%	20%	0%	1,399,000	1,034,000
Equipment	Dryers	3,200,000	2002	2005	0%	80%	20%	0%	3,732,000	2,756,000
Equipment	Dryer ID Fan	1,000,000	2002	2005	0%	80%	20%	0%	1,166,000	861,000
Equipment	Kiln Dust Storage Mechanical	900,000	2002	2005	0%	80%	20%	0%	1,050,000	775,000
Equipment	Cake Screw Conveyor to Feed Bins	5,100,000	2002	2005	0%	80%	20%	0%	5,948,000	4,393,000
Equipment	Cake Screw Conveyor w/in Bins	7,155,000	2002	2005	0%	80%	20%	0%	8,344,000	6,163,000
Equipment	Truck Loader	360,000	2002	2005	0%	80%	20%	0%	420,000	310,000
Equipment	Hg Control Equipment	-	2002	2005	0%	80%	20%	0%	-	-
Equipment		-	2002	2005	0%	80%	20%	0%	-	-
Equipment		-	2002	2005	0%	80%	20%	0%	-	-
Equipment		-	2002	2005	0%	80%	20%	0%	-	-
Equipment		-	2002	2005	0%	80%	20%	0%	-	-
Equipment		-	2002	2005	0%	80%	20%	0%	-	-
Equipment		-	2002	2005	0%	80%	20%	0%	-	-
Equipment		-	2002	2005	0%	80%	20%	0%	-	-
Equipment	Electrical (10% of Equipment)	4,372,000	2002	2005	0%	80%	20%	0%	5,099,000	3,766,000
Equipment	I&C (7% of Equipment)	3,060,000	2002	2005	0%	80%	20%	0%	3,569,000	2,636,000
TOTAL CONSTRUCTION COST		141,254,000							163,908,000	122,290,000
Undeveloped Design Details (25%)		35,300,000	2002	2005				n/a	40,977,000	27,252,000
Engr'g, Admin,Training,Legal & Contingency (25%)		44,100,000	2002	2005				n/a	51,221,000	34,065,000
TOTAL PROJECT COST		220,654,000	2002	2005					256,106,000	183,607,000

MCES SOLIDS PROCESS IMPROVEMENTS PROJECT
LIFE-CYCLE COST ANALYSIS
6 **Full Alkaline Stabilization**

O&M COSTS

Units	Item	Present Annual Cost	Escalated Annual Cost	Present Worth
2005 - 2025 Estimated O&M Costs		1998	2005	
32	FTE Labor	2,192,000	2,696,000	
-	MBTU of Natural Gas	-	-	
25,732,200	KwHrs of Electricity	1,179,000	1,450,000	
209,200	Land Application of Digested Solids	4,184,000	5,146,000	
-	tons of ckd	-	-	
978,930	pounds of polymer	2,203,000	2,709,000	
-	electrical credit @$.025/kwhr	-	-	
-	electric demand credit	-	-	
-	gals of fuel oil	-	-	
	maintenance-materials	1,534,000	1,887,000	
	Odor Control Chemicals	100,000	123,000	
TOTAL		11,392,000	14,011,000	140,636,543

USPW Factor 13.2105 (USPW refers to uniform stream present worth factor, 6 percent over 32 years, from 1998 to 2025)

END-PRODUCT USES

Units	Item	Present Annual Cost	Escalated Annual	Present Worth	Present Worth
		1998	2005		
-	N/A	-	-		0

LIFE CYCLE COSTS

TOTAL PRESENT WORTH	317,745,543
TOTAL EQUIVALENT ANNUAL COST	24,052,000

MCES SOLIDS PROCESS IMPROVEMENTS PROJECT
LIFE-CYCLE COST ANALYSIS
6 Full Alkaline Stabilization

REPLACEMENT COSTS

Type	Item	Useful Life	Replacement First	Second	Third	Fourth	Fifth	Escalated Cost (First)	Present Worth
Structure	Foundation	50	0	0	0	0	0	-	-
Structure	Concrete	50	0	0	0	0	0	-	-
Structure	Metals	50	0	0	0	0	0	-	-
Structure	Paint/Waterproofing	50	0	0	0	0	0	-	-
Structure	Electrical Duct Bank	50	0	0	0	0	0	-	-
Structure	Tunnels	50	0	0	0	0	0	-	-
Structure	Kiln Dust Storage Silos	50	0	0	0	0	0	-	-
Structure	Dewatering/Alkaline Mixing	50	0	0	0	0	0	-	-
Structure	Drying	50	0	0	0	0	0	-	-
Structure	Alkaline Product Storage	50	0	0	0	0	0	-	-
Structure	Odor Control / Chemical Storage	20	0	0	0	0	0	-	-
0	0	20	0	0	0	0	0	-	-
Equipment	Move and Refurbish One Centrifuge	20	0	0	0	0	0	-	-
Equipment	Centrifuge Feed Pumps	15	2020	0	0	0	0	2,299,000	638,000
Equipment	Dewatering Centrifuges for Cake St	20	0	0	0	0	0	-	-
Equipment	Boilers for Plant Heating	20	0	0	0	0	0	-	-
Equipment	Process Piping	15	2020	0	0	0	0	14,946,000	4,147,000
Equipment	Odor Control Dryer Exhaust w/ WetV	15	2020	0	0	0	0	9,197,000	2,552,000
Equipment	Odor Control Storage	15	2020	0	0	0	0	17,245,000	4,786,000
Equipment	Mixers	15	2020	0	0	0	0	3,449,000	957,000
Equipment	Dryers	20	0	0	0	0	0	-	-
Equipment	Dryer ID Fan	15	2020	0	0	0	0	2,874,000	798,000
Equipment	Kiln Dust Storage Mechanical	15	2020	0	0	0	0	2,587,000	718,000
Equipment	Cake Screw Conveyor to Feed Bins	15	2020	0	0	0	0	14,658,000	4,068,000
Equipment	Cake Screw Conveyor w/in Bins	20	0	0	0	0	0	-	-
Equipment	Truck Loader	20	0	0	0	0	0	-	-
Equipment	Hg Control Equipment	20	0	0	0	0	0	-	-
Equipment	0	20	0	0	0	0	0	-	-
Equipment	0	20	0	0	0	0	0	-	-
Equipment	0	20	0	0	0	0	0	-	-
Equipment	0	20	0	0	0	0	0	-	-
Equipment	0	20	0	0	0	0	0	-	-
Equipment	0	20	0	0	0	0	0	-	-
Equipment	0	20	0	0	0	0	0	-	-
Equipment	Electrical (10% of Equipment)	15	2020	0	0	0	0	12,566,000	3,487,000
Equipment	I&C (7% of Equipment)	15	2020	0	0	0	0	8,795,000	2,441,000
TOTAL								88,616,000	24,592,000

MCES SOLIDS PROCESS IMPROVEMENTS PROJECT
LIFE-CYCLE COST ANALYSIS
6 Full Alkaline Stabilization

TERMINAL VALUES

Type	Item	Useful Life (Years)	Useful Life at End of Planning Period	Escalated Terminal Value	Present Worth
Structure	Foundation	50	30	(21,828,000)	(4,526,000)
Structure	Concrete	50	30	(23,826,000)	(4,941,000)
Structure	Metals	50	30	(8,214,000)	(1,703,000)
Structure	Paint/Waterproofing	50	30	(582,000)	(121,000)
Structure	Electrical Duct Bank	50	30	(1,733,000)	(359,000)
Structure	Tunnels	50	30	(2,132,000)	(442,000)
Structure	Kiln Dust Storage Silos	50	30	(4,798,000)	(995,000)
Structure	Dewatering/Alkaline Mixing	50	30	(4,478,000)	(929,000)
Structure	Drying	50	30	(11,942,000)	(2,476,000)
Structure	Alkaline Product Storage	50	30	(29,270,000)	(6,070,000)
Structure	Odor Control / Chemical Storage	20	0	-	-
0	0	20	0	-	-
Equipment	Move and Refurbish One Centrifuge	20	0	-	-
Equipment	Centrifuge Feed Pumps	15	10	(1,185,000)	(246,000)
Equipment	Dewatering Centrifuges for Cake St	20	0	-	-
Equipment	Boilers for Plant Heating	20	0	-	-
Equipment	Process Piping	15	10	(7,700,000)	(1,597,000)
Equipment	Odor Control Dryer Exhaust w/ WetV	15	10	(4,739,000)	(983,000)
Equipment	Odor Control Storage	15	10	(8,885,000)	(1,842,000)
Equipment	Mixers	15	10	(1,777,000)	(368,000)
Equipment	Dryers	20	0	-	-
Equipment	Dryer ID Fan	15	10	(1,481,000)	(307,000)
Equipment	Kiln Dust Storage Mechanical	15	10	(1,333,000)	(276,000)
Equipment	Cake Screw Conveyor to Feed Bins	15	10	(7,552,000)	(1,566,000)
Equipment	Cake Screw Conveyor w/in Bins	20	0	-	-
Equipment	Truck Loader	20	0	-	-
Equipment	Hg Control Equipment	20	0	-	-
Equipment	0	20	0	-	-
Equipment	0	20	0	-	-
Equipment	0	20	0	-	-
Equipment	0	20	0	-	-
Equipment	0	20	0	-	-
Equipment	0	20	0	-	-
Equipment	0	20	0	-	-
Equipment	Electrical (10% of Equipment)	15	10	(6,474,000)	(1,343,000)
TOTAL				(149,929,000)	(31,090,000)

Metro Solids Improvement Project, Technology Selection, Public Hearing and Workshop Response

Introduction: The Metropolitan Council (the "Council") conducted a public hearing on March 26, 1998, on the question of which wastewater solids management technology should be selected to replace the existing multiple hearth incinerators currently in use at the Metro Plant. Over the last several years a number of different technologies for solids management at the Metro Plant were studied. The matrix attached as Exhibit A summarizes the various technologies studied.

Two technologies were selected for further study based on a variety of factors including cost, environmental impacts, site constraints and odors. The public hearing focused on these two technologies: (1) fluidized bed incinerators to use the heat value of wastewater solids and (2) heat dryers, alone or in combination with anaerobic digestion, to use the nutrient value of wastewater solids in a fertilizer product. Staff recommended the installation of fluidized bed incinerators to replace the current incinerators.

Following the hearing on April 28, 1998, a workshop was conducted with the Council's Environment Committee for anyone interested in providing comment.

This document summarizes the issues raised by the public at both the hearing and workshop, and provides the Council's responses. Part One of this Response provides information for issues raised during the public hearing. Part Two of this Response provides information on new issues raised during the workshop.

PART ONE: PUBLIC HEARING RESPONSE

There were nine major areas in which testimony was given at the hearing or written comments received prior to the public record closing on April 9, 1998 including: 1) Clean Air Act Emissions, 2) Mercury Control, 3) Greenhouse Gas Emissions, 4) Odor Control, 5) Sustainable Development, 6) Market and Economic Assumptions, 7) Energy Efficiency, 8) Environmental Review and 9) Miscellaneous. Responses are provided by topic.

1. CLEAN AIR ACT EMISSIONS:

Public Comments: Metals and particulates will be put into the river. What price is too high to avoid lead, cadmium and mercury emissions? There will be more sulfur dioxide (SO_2), oxides of nitrogen (NOx), and carbon monoxide (CO) pollution with incineration than other options.

Appendix G

(a) Metal Emissions

Metal releases to the air and land for either technology are below U.S. EPA emission standards, which are designed to protect our health and environment. Total metal releases to the environment are summarized in Table 1.

Table 1
Expected Total Annual Metals Released to the Environment

Pollutant in Pounds	Existing Multiple Hearth Incinerators	Fluidized Bed Incinerators	Dryers	Dryers/ Digestion
Lead				
Air Emission	210	170	170	100
Ash/Biosolids	17,050	17,090	17,090	17,160
TOTAL (pounds)	17,260	17,260	17,260	17,260
Cadmium				
Air Emission	79	63	63	36
Ash/Biosolids	1,485	1,501	1.501	1,528
TOTAL (pounds)	1,564	1,564	1.564	1,564

The Metro Plant does not create nor destroy metals. The plant processes merely remove the metals from one media (wastewater), and transfers them to other media (air, ash, or biosolids). The ultimate fate of the metals is dependent on the solids processing technology. The metals removed from the wastewater accumulate in the solids. The air pollution control equipment for either new technology being considered will recover (capture) roughly 99 percent of all of the particulates and 70-99 percent of the metals, depending upon the metal, removed from the wastewater. The exhaust air particulates and metals not captured by the air pollution control equipment will be released to the atmosphere as air emissions.

With the incinerator option, the captured particulates will be in the form of ash. The ash, and the metals contained in it, will be utilized in construction products, or NutraLime, which is a blend of ash and water treatment lime that is applied to farm land. Rigorous testing has shown that the heavy metals are tightly bound in the ash and do not leach into the environment.

With the dryer/digestion option, the retained particulates and metals will be in the form of pellets and liquid digested sludge. The pellets and sludge will be land spread, which will release the metals into the environment. Some metals are fairly stable when mixed with the soils, others are more reactive and subject to uptake by crops.

(b) CLEAN AIR ACT EMISSIONS

Expected emissions from each technology option are generally equivalent. Table 2 summarizes the expected emissions associated with each technology option in the year 2005. As shown in Table 2, incinerators have lower expected emissions for PM, PM_{10}, and SO_2, and dryers/digestion have lower emissions for NO_X, VOC, and CO. Both technologies under consideration will result in a substantial reduction in actual NO_X, CO, PM, and PM_{10} emissions compared to the existing incinerators.

Table 2
Comparison of Expected Annual Air Emissions for the Technology Options With Existing Multiple Hearth Incinerator Emissions

Pollutant	Existing Multiple Hearth Incinerator (ton/yr)	Proposed Fluidized Bed Incinerator Option (ton/yr)	Proposed Dryer Option (ton/yr)	Proposed Dryer/ Digestion Option (ton/yr)	Advantage
PM	35	2.8	6.9	5.1	FBI
PM10	38	2.8	6.9	5.1	FBI
SO_2	15	15	34	24	FBI
NOx	440	152	127	88	Dryer/Digestion
VOC (as THC)	12	6.0	7.1	4.3	Dryer/Digestion
CO	703	97	47	30	Dryer/Digestion
PCDD/PCDF	0.0000014	$\leq$0.0000014	$\leq$0.0000014	$\leq$0.0000014	No Advantage

PM = particulate matter
PM10= particulate matter less than 10 micrometers in diameter.
SO_2= sulfur dioxide
NO_x= oxides of nitrogen
VOC= volatile organic compounds
THC= total hydrocarbons
CO= carbon monoxide
PCDD/PCDF= dioxins

2. *MERCURY CONTROL:*

Public Comments: Mercury reduction and control is needed. Recycling lead, cadmium and mercury to the land is preferred. Emissions of 297 pounds of mercury per year is too much, and more than all coal burning plants. Heat drying won't volatilize mercury. Mercury will not go directly to water with heat drying. Mercury source reduction is important to any option. The Council report on mercury for dental waste is inaccurate.

The Council has been involved in mercury reduction efforts for fifteen years, primarily as a regular part of its Industrial Waste Pretreatment Program. As a result of this involvement, the mercury concentration in the wastewater solids has been reduced by more than 50%. The contribution of mercury contamination from sewage treatment is small compared to all other man-made sources.

On April 23, 1998, the Metropolitan Council adopted a Mercury Reduction Strategy that focuses on pollution prevention and control. A Mercury Core Team has been assembled to develop a Mercury Reduction Implementation Plan. The Reduction Plan will be developed to provide the most effective balance of mercury pollution control and prevention approaches to achieve the long-term improvement of the air and water quality for the region, to protect the public health and the environment, and to support the state's initiative to reduce mercury contamination in fish.

The mercury releases for incineration and dryer systems are equal. The fate of the mercury is the only difference. The boiling point of mercury is approximately 670 degrees Fahrenheit, and the temperature of the air going into the dryers would be between 700 and 900 degrees Fahrenheit thereby volatilizing any mercury.

The Council does not have on file reliable estimates of facility-specific mercury emission rates for any other source. This information may be available from the Minnesota Pollution Control Agency. The Council's focus is to reduce its own mercury emissions since it does not have the ability to impact others.

The estimate of 297 pounds of mercury presented in the report "Evaluation of Alternative Technologies for Solids Handling at the Metro Plant" ("Tech. Memo"), represents potential air emissions from the incinerator option. Potential air emissions are based upon all equipment running at capacity at all times. The Metro Plant must be able to provide continuous uninterrupted service to its service area. A portion of the equipment with each technology is for redundancy and reliability and is not operated continuously at its rated capacity but is used in the calculation of potential emissions. Therefore, actual emissions provide a more realistic basis for emission comparison. Potential emissions are used solely for determining which Clean Air Act rules apply to the project. Expected actual emissions are based on the projected wastewater solids amounts, the current mercury concentration in the wastewater solids, and a projected control efficiency of 70 percent.

Table 3
Comparison of Expected Mercury Released to the Environment in 2005

Fate of Mercury (lbs/yr)	Existing Multiple Hearth Incinerators	Fluidized Bed Incinerators	Dryers	Dryers/ Digestion
Air Emission	240	70	70	15
Ash/Biosolids	0	170	170	225
TOTAL	240	240	240	240

The Council has not assumed any further reductions in mercury concentration in the wastewater solids even though sampling data shows consistent downward trends in the mercury concentration over the last nine years. Recent incineration test data shows that a 70-percent reduction in mercury emissions could be achieved.

The Council understands that the Minnesota Dental Association's estimates of the mercury contribution from dentists in the region are different than the Council's. That is why the Association and the Council have developed a partnership to work together so that the parties can better understand the contributions from dentists and develop effective pollution prevention and control strategies.

3. *GREENHOUSE GAS EMISSIONS:*

Public Comments: The proposed project will not comply with Kyoto Protocol. All carbon dioxide ("CO_2") emissions and CO_2 equivalents, not just fossil fuel use, need to be analyzed. The assumption is that burning sludge as a fuel produces CO_2. What are the other sources of greenhouse gases; methane, maybe nitrous oxide ("N_2O")?

Prior to the hearing, the Council conducted a preliminary assessment of greenhouse gas emissions associated with the two technology options being considered. Based on this analysis, the fluidized bed incineration option was determined to be superior to the dryer options. This was due primarily to the much lower fossil fuel consumption rate by the fluidized bed incinerator option compared with the heat drying options. The Council's analysis is consistent with existing EPA guidance to estimate greenhouse gas emissions based upon fossil fuel use. The Council wants to reduce reliance on fossil fuel and this is accomplished through fluidized bed incineration.

The recent Kyoto Protocol calls for a reduction in future greenhouse gas emissions to a level less than emissions in 1990. Several commentors requested additional analysis of greenhouse gas emissions, including emissions from sludge combustion. This additional analysis shows that the overall greenhouse gas emissions are essentially equal for the technology options.

To address the issues raised by the commentors, the Council performed a more comprehensive analysis which included both CO_2 and N_2O emissions; N_2O emission data were obtained during testing in April 1998 using a pilot scale fluidized bed reactor. The refined analysis addressed the following elements:

- fossil fuel combustion in the incinerators, dryers, after burners, and boilers
- sludge combustion in the incinerator
- fossil fuel combustion in haul trucks
- the reduction in off-site fuel use associated with producing electricity
- the reduction in off-site fuel use associated with the production of anhydrous ammonia

Table 4 shows the revised greenhouse gas emission estimates for each of the processing technologies.

Table 4
Comparison of CO_2, N_2O, and Total Greenhouse Gas Emissions Associated with Sludge Combustion and Biosolids Production and Use

Technology Option and Emission Source	CO_2 Emissions as Carbon Equivalent (ton/yr)	N_2O Emissions as Carbon Equivalent (ton/yr)	Total Greenhouse Gas Emissions as Carbon Equivalent (ton/yr)
Existing Multiple Hearth Incinerators	29,700	No data	39,700
Proposed Fluidized Bed Incinerators	34,300	13,400	48,800
Proposed Dryers (low N product)	46,100	6,400	52,500
Proposed Dryer/Digestion	38,000	6,400	44,400

CO_2= carbon dioxide
N_2O=nitrous oxide

Emissions in Table 4 are reported as carbon (C) equivalents, which is the common method for expressing greenhouse gas emissions. N_2O can contribute a significant amount to total greenhouse gas emissions. Methane (CH_4), another greenhouse gas, is also associated with some of the drying technologies. However, reliable emission estimates are not available and were not included in Table 4.

4. *ODOR CONTROL:*

Public Comments: Support expressed for incineration as the preferred technology with the least potential for odors. Why does the Tech. Memo state odor control costs are the same for both technologies? Assumption: the odors must therefore be the same.

Incineration is preferred over drying in regards to odors. Both technologies include sources of odors and as such require odor control systems. While the systems can be designed to minimize odors, technologies with multiple odor sources create more challenges. Dryer systems include numerous material handling systems (or odor sources) where capturing of the odors is difficult.

In the Tech. Memo, the costs listed for odor controls were for dewatering systems. Dewatering is a necessary part of all of the alternatives and the same method of dewatering will be applied with either technology. The costs for odor controls that would be used for the dryer and dryer/digestion systems were listed under the general equipment category as opposed to the odor control category. The primary odor control device for the dryer options would be the regenerative thermal oxidizer (RTO), which is a type of afterburner that will burn up the odors. The incinerators effectively serve as thermal oxidizers, and therefore, no stack odor control is required.

5. *SUSTAINABLE DEVELOPMENT:*

Public Comments: How does the recommendation fit with the Council's position on sustainable development? What is a reasonable price for sustainability? Recycling of nutrients is preferred; it is a natural cycle. Land application equals sustainability by putting carbon, nitrogen and organics back in the soil. Recycling the organics to the soil is preferred. Minnesotans support recycling.

Sustainable development considers a very broad range of factors. The Minnesota Planning and Environmental Quality Board in its document, *Sustainable Development; The Very Idea,* published a set of factors by which sustainable development can be assessed.

The recommended alternative is sustainable because of the following:

1. Incineration offers the lowest use of fossil fuels. (The dryer technology's reliance on fossil fuels does not meet the Environmental Quality Board's criteria of gradually reducing the reliance on non-renewable energy sources.)
2. Incinerators offer significantly lower emission of air pollutants of concern than the current multiple hearth incinerators and equivalent levels of emissions as the heat dryer alternative.
3. Total release of heavy metals to the environment is equal regardless of technology.
4. The heat value of wastewater solids is used for plant heating and co-generation. In the drying alternative, the organic and nutrient value is used for land application.
5. Mercury reduction and control is needed for each alternative. Mercury that is volatilized is captured in the air pollution control system.
6. The fluidized bed incinerator alternative is a lower capital cost alternative by approximately \$30 million in capital costs and approximately \$50 million in total life cycle costs. This is money that may be available for another public purpose.
7. The incineration alternative has only one source of odor; the dewatering equipment. The heat dryer has numerous materials handling systems that create a potential for odor and for which odor control will be required.

6. *MARKET AND ECONOMIC ASSUMPTIONS:*

Public Comments: Market study for pellets was biased. Farmers want pellets or N-Viro; there is a local market that represents a long term opportunity. Farmers save \$20/acre with pellets. Pellet market seems better than the ash market. Assumptions used for developing the costs of two technologies could change recommendation if modified.

The market study identified local markets and assumed \$30/ton gross revenues from local (within 60 miles) farmers. During the workshop on April 28, 1998, a farmer representing Washington and Dakota Counties, indicated that \$30/ton gross was too high. The life cycle cost analysis assumed \$53.00 per ton to recycle the ash into concrete products. The Ash Study indicated a yet untapped market for ash with a lower charge.

What is the Sensitivity of Total Project Costs to Changes in Cost Assumptions? Comparing the life cycle costs of alternative projects is a way to evaluate their relative economic merits. Life cycle cost is an economic measure of all of the costs expected to be incurred over the life of a project. Life cycle costs normally include: 1) up-front capital costs, 2) ongoing annual operations and maintenance ("O&M") costs, 3) revenues expected to be derived from the project, if any, 4) periodic replacement costs of specific structures and pieces of equipment, and 5) the terminal or salvage value of the project at the end of the planning period.

Table 5 below presents the life cycle cost for each technology alternative if dried product revenue and ash utilization cost assumptions were changed. The fluidized bed incineration alternative presented is that which includes installation of four incinerators. The first scenario illustrates the changes in life cycle cost in response to different assumptions about the revenue produced from sales of dried product. The net revenue received from the sale of dried product was assumed to increase by 100 percent to $15.66 per dry ton. The second illustrates the changes in life cycle cost in response to changes in the cost to beneficially utilize incinerator ash. The cost was assumed to decrease by 50 percent to $26.50 per ton. The third illustrates the changes in life cycle costs for both alternatives if all material produced (dried product or ash) had to be landfilled.

To conclude, the ranking of the alternatives from least to greatest life cycle cost does not change under any of the above scenarios.

Table 5
How Life Cycle Costs Change in Response to Changes In Dried Product Revenue and Ash Utilization Costs

	Fluidized Bed Incineration	Heat Drying (High Nitrogen)
Project Cost	$214,581,000	$263,344,000
Annual O&M Cost	$8,716,000	$12,322,000
Ash Disposal Cost	$1,283,000	n/a
Product Revenue	n/a/	$484,000
25-Year Life Cycle Cost	$328,800,000	$363,900,000
If Dried Product Revenue Were to Increase by 100% and Ash Costs Were Held Constant	$328,800,000	$358,900,000
If the Cost to Utilize Ash Were to Decrease by 50% and Dried Product Revenue Were Held Constant	$321,400,000	$363,900,000
If All Materials Had to Be Landfilled	$322,300,000	$388,000,000

7. *ENERGY EFFICIENCY:*

Public Comments: Co-generation was not adequately explored. Does the plan maximize the energy efficiency of the plant?

Co-generation is included in the fluidized bed incinerator option. Heat from the incinerator is used for plant heat and recycled to a turbine generator where electricity is produced for use in the treatment plant. This offsets the purchase of electricity and natural gas which is a conservation measure since a renewable resource is used.

Plant heating and co-generation are not included in the heat drying alternative. Natural gas is used for drying the wastewater solids to produce a dried pellet. The exhaust gases coming off the dryer are recirculated in order to reduce the natural gas requirement. The temperature of the exhaust gases is insufficient for plant heating or for co-generation.

Plant heating and co-generation is not included in the heat drying with digestion alternative. Gas produced by the digestion process will be used as a fuel in the dryers, however, supplemental natural gas is still required for the dryer and the temperature of the exhaust gases from the dryers is insufficient for plant heating or for co-generation.

The treatment plant has already accomplished numerous efforts to maximize the energy efficiency of the plant. Two examples are fine bubble deaeration conversion ($1.2 million savings/year) and changing over all fluorescent lighting to new energy efficient lighting.

8. *ENVIRONMENTAL REVIEW:*

Public Comments: Without mercury reduction and control, an Environmental Impact Statement (EIS) is warranted. Others would like to see an Environmental Assessment Worksheet (EAW) done on all options. An EIS should be completed which would analyze alternative methods, sites and economic justification.

Environmental impacts related to the solids project will be beneficial regardless of the technology selected. In addition, there is not a mandatory trigger requiring the preparation of an EAW for either technology. An EAW is a document prepared to assess the environmental effects that may be associated with a proposed project. The Council has volunteered to prepare an EAW which will compare the selected technology with existing conditions. The Council will complete a voluntary EAW in 1998.

9. *MISCELLANEOUS:*

Public Comments: Public awareness of hearing on incineration was inadequate; concerned with stack height on the river; more jobs will be available with pellets; incineration is lower on the solid waste hierarchy.

1. **Public Awareness Efforts To Date:**
Throughout the solids project, the goal has been to inform all stakeholders about the new solids facility and the impacts of the project. The following list represents the communications and outreach that occurred prior to the public hearing on March 26, 1998:

Community Meetings: Citizen and city representatives were convened in four different locations to test communications tools, and provide feedback on perceptions regarding wastewater treatment, processing technology, and rates. Over 200 contacts were made. Forty city administrators/representatives attended small group settings, were informed of the project, and offered suggestions/opinions.

Business Community: Meetings have been held with the Minnesota Chamber Water Quality Task Force, Greater Minneapolis Chamber, St. Paul Riverfront Corp., and the St. Paul Area Chamber to inform them and respond to their concerns related to the project. In addition, local business groups such as the East Side Area Business Association and the Concord Street Business Association were mailed information on the project.

Regulatory Meeting: A meeting was held gathering various regulators from the MPCA, DNR, U.S. Fish and Wildlife, etc. to inform, respond to concerns, and discuss regulatory issues related to the project. Twenty-seven regulators were invited and most attended.

Environmental Groups: Individual meetings were held with several environmental groups informing them of the project. Metro area environmental groups were invited to visit the Metro Plant to discuss the project and their concerns. Over 48 environmental groups have received information on the solids project and have been informed of opportunities for public input. This list includes: Friends of the Mississippi River; Mississippi River Project - Citizens for a Better Environment; and River Environmental Action Project in South St. Paul.

Informational Meeting: This informal gathering provided an opportunity for neighbors and other interested individuals to learn about the solids processing project.

Town Meeting: This forum allowed the Council to receive feedback and comments from affected neighbors and other interested parties.

The Informational and Town meetings were promoted in a variety of ways. Personal invitations describing the solids processing options being considered were mailed to over 100 interested individuals and organizations. In addition to community meeting participants, business groups, regulators and environmental groups, the following were also notified: six local and metro newspapers, Metro Plant neighbors, legislators, City Council Members, Ramsey County Commissioners, St. Paul Planning Commission, St. Paul Public Works, St. Paul Mayor's Office, District Councils 1, 3, 4, 7 and 17 and Westside Community Citizen's Organization.

Press releases and a personal invitation were sent to area media. Fliers were posted in the Daytons Bluff neighborhood and on the west side: Mounds Park Center, Conway Rec Center, Daytons Bluff library, Battle Creek Rec Center and El Rio Vista Rec Center.

Informational Packet: At the beginning of February, an informational packet was mailed to 240 interested individuals and organizations. This information provided an update on staff's recommendation, information from the technical memo and announced the date for the public hearing.

This document was mailed to all individuals and organizations expressing an interest in the project as well as those that had participated or been informed of community outreach activities.

Notice of Public Hearing: Notice of the public hearing was published in the State Register, Star Tribune, Pioneer Press, St. Paul Legal Ledger and East Side Newspaper. In addition, news releases were provided to key papers. These releases indicated that incineration was being considered. Papers did not use the news release. Because we anticipated that the papers may not consider this project sufficiently newsworthy to publish the releases, arrangements were made for various ads to be placed in small community papers and the Pioneer Press. Because of insufficient space to fully explain both alternatives, the ad stressed that wastewater solids processing would be improved.

Workshop: The recent workshop with the Council's Environment Committee was publicly noticed. In addition, individuals attending all prior meetings on the project received an invitation to the workshop.

2. **Stack height on the river creates concern:** The proposed stack is farther from the river than the existing stacks and will be the same height.

3. **More jobs will be available with drying:** The Council is involved in an effort to reduce staff to become more efficient and competitive.

4. **State perspective on solid waste management:** The 1980 Waste Management Act states: "the waste management goal of the state is to foster an integrated

waste management system in a manner appropriate to the characteristics of the waste stream and thereby protect the state's land, air, water, and other natural resources and the public health. The following waste management practices are in order of preference:

1) waste reduction and reuse;
2) waste recycling;
3) composting of yard waste and food waste;
4) resource recovery through mixed municipal solid waste composting or incineration; and
5) land disposal.

The Council's practices are consistent with this hierarchy and will remain consistent with fluidized bed incinerators, including: 1) the Council's Industrial Waste Pretreatment Program which requires the reduction of waste prior to disposal to the sewer system.; 2) Wastewater solids incinerator ash which is beneficially used; and 3) the heat value of the wastewater solids recovers this resource to provide energy for the incinerators as well as for providing sufficient energy to heat the Metro Plant.

5. **Other:** Responses to two letters with numerous, specific questions can be found in Exhibit B.

PART TWO: RESPONSE TO STATEMENTS AND QUESTIONS FROM THE SOLIDS PROJECT WORKSHOP ON APRIL 28, 1998

(numbered consecutively with Public Hearing Response)

10. **The Metro Plant cannot produce a product the quality of Milwaukee's Milorganite. Why not?**

    Response: The nitrogen content of wastewater solids is based upon how much primary sludge and secondary sludge is used to produce the final product. In Milwaukee, they have the ability to use all secondary sludge and produce a product that is consistently at 6% nitrogen. The solids from the Metro Plant is a minimum of 30% primary and 70% secondary. Corresponding average nitrogen content is approximately 5%.

11. **If the Metro Plant produced a No. 1 product, I would pay double what the contractor is currently being offered. How can I get product for my farm in Chisago City?**

    Response: Rehbein holds the contract with the Council for marketing and land application of the N-Viro product. They make all of the decisions about marketing the product at this time. Rehbein is responsible for all the equipment to spread the product.

12. **Can the product be spread year-round and will farmers be willing to pay $30/ton?**

    Response: In the months of May, June and July when the fields are being worked, a farmer would not want the product applied. A Class A product could be applied at all other times of the year provided the trucks can deal with the snowy conditions.

    The value of the pellets is the nitrogen content. Based upon an equal amount of nitrogen in commercial fertilizers, no more than $20 per ton would be the current market price. This assumes that the product application and other factors would be equal, otherwise an even lower price may be all that the market would bear.

13. **Would heat drying do less to eliminate odors than the incinerator?**

    Response: Yes. The Council believes that heat drying will be an improvement with respect to odors when compared to current conditions. However, the nature of the heat drying process is such that there are many more sources to control. Others using heat drying have experienced occasional odor problems.

14. **How can the odor reduction be quantified (measured) for the two technologies?**

Response: Odors are measured by citizens who will actually smell samples and develop odor units. Then the plant odors would be measured, in terms of odor units. How and where you measure odor units is often site specific.

15. **Since the Council is considering heat drying at the Blue Lake WWTP, what is The Council's level of concern related to odors at that facility?**

Response: The Council will install odor control systems to deal with the odors to the extent possible. The Blue Lake plant is 1/10 the size of Metro and in a different geographic location.

16. **Regarding mercury, what type of mercury is emitted? What type of pollution control equipment is planned to control mercury? What happens to mercury if it is in the ash and then made into concrete, for example, when the structure with the concrete is demolished?**

Mercury contained in the incinerator exhaust gases and dryer exhaust gases will be present as elemental mercury and oxidized mercury. Recent singular test data using Metro solids at a pilot scale fluidized bed incinerator showed that up to 30 % of the mercury is elemental. The remaining is oxidized mercury. There is no available data on the mercury speciation in dryer exhaust gases.

The oxidized mercury species can be controlled using particulate air pollution control equipment. Both the fluidized bed incinerator and the dryers will include such control equipment. The air pollution control train currently being considered for the fluidized bed incinerators includes cyclones, a dry electrostatic precipitator, a venturi scrubber, and a wet electrostatic precipitator. The air pollution control train currently being considered for the dryers includes cyclones, a venturi scrubber, a wet electrostatic precipitator and an RTO.

Concrete from demolition projects could be ground up and used for road base or could be disposed of in a construction and demolition debris landfill. The mercury in either case would be remain encapsulated in the concrete.

17. **How much cadmium is produced? The concern is that cadmium is taken up by plants. Are there PCBs or dioxins resulting from incineration or the use of the product? What were the results of 15 years of tracking agricultural use of the Metro Plant's sludge in Rosemount in terms of heavy metals?**

Response: The study done by the University of Minnesota in Rosemount did look at the fate of metals contained in applied solids. The study showed no statistical increase in the cadmium and lead concentrations in corn tissues grown in sledgetreated soils compared to corn grown in the control soils. Cadmium, lead and mercury limits are below EPA limits.

18. **How can biosolids be an energy source when they are 70% water? How efficient of an energy source can it be in a fluidized bed incinerator?**

Response: The thermal efficiency of a fluidized bed incinerator is about 50% compared to a natural gas furnace of 80-85%. The sludge will first be dewatered through the centrifuges. Then a heat dryer would use natural gas to dry the product. In the case of the fluidized bed incinerator, the fuel value of the wastewater solids will drive off the water remaining in the incoming wastewater solids as it incinerates and produces ash.

19. **Is formal input from the MPCA needed before the Council makes a technology choice?**

Formal input from the MPCA is not necessary for a technology selection. To date, MPCA staff has been supportive of either technology and they have approval authority for the Facility Plan. Both MPCA and the EPA are very interested in the Council moving forward to improve air emissions regardless of technology.

Exhibit A

Alternative Solids Technologies

	Resource Recovery	Outside Levy or Off Site	Odors	Air Emissions from Processing	Market Distance	Truck Traffic (Trucks/Year or Day)	Change In Resources Utilized	Equivalent Annual Cost (millions)
Anaerobic Digestion	Methane can be used to heat plant; nutrients captured; used as fertilizer	Yes 82 acres	From storage	Methane off-gases	60 miles	120 trucks/day over 3 months (Spring and Fall peak) (10,000 trucks/year)	Significant reduction of current electrical needs	$14.4
Composting	Nutrients captured; used as fertilizer	No	From processing, storage and use	Possible infectious agents	60 miles	60 trucks/day for 3 months (Spring and Fall peak) (5,400 trucks/year)	Increased electrical for centrifuges and blowers. Additional trucking for wood chips	$18.0
Alkaline Stabilization	Nutrients captured; used as fertilizer	No	Ammonia	Particulate matter	60 miles	60 trucks/day for 3 months (Spring and Fall peak) (5,400 trucks/year)	Increased electrical for centrifuges. Trucking of lime as amendment.	$18.5
Heat Drying	Nutrients captured; used as fertilizer	No	Potentially from processing	Off-gases from heating	60 miles	10 trucks/day year round (7 days/week) (3,600 trucks/year)	Increased electrical for centrifuge. Increased natural gas.	$15.5
Incineration	Waste heat used to heat plant hand run turbine for electricity	No	Minimal	Combustion gases	Existing 3 state area	2 trucks/day year round (730 trucks/year)	Increased electrical for centrifuges and blowers.	$13.3

Exhibit B

May 19, 1998

Mr. Sheldon Johnson
2031 Howard Street S.
St.Paul, MN 55119

Re: Response to Questions
Metro Plant Solids Processing Project
MCES Project 970300

Dear Mr. Johnson:

The following are responses to your questions submitted to me on April 9, 1998, as part of the public hearing record, and the questions that you faxed to me on April 15, 1998. I have also included the package from the public hearing and the workshop that contains the public hearing record and the testimony from the workshop. I apologize for the delay in getting this information to you.

1. Attached you will find a copy of Section 8 - Solids Alternatives, from the Metro Plant Master Plan. This Section goes through the 12 alternatives, the monetary and non-monetary factors, and the cost breakdown for each alternative. There is more information in the Metro Master Plan on liquids alternatives and alternatives combining solids and liquids. If you would like a complete copy just let me know.

2. Air emissions from incineration have already been heavily regulated while land application has not been put through the same scrutiny. Land application is not a process that lends itself to testing, whereas, testing of incinerator emissions has been done for many years, and testing equipment for incineration emissions is readily available. However, you will see that we did not give either technology an advantage in regards to regulatory risk.

3. With the adoption of Part 503 of the Code of Federal Register, land application of sewage sludge became more acceptable to the public. There are now many municipalities that land apply their digested sewage sludge. There are equally a large number of municipalities that incinerate their sludge. In comparison, very few municipalities land apply biosolids. Each municipality, not unlike the Council, has different sludge characteristics, abilities of personnel, climate, and different values held by the organization that has authority over the treatment plant. We need to make the decision that is best for the Twin Cities and Minnesota environment.

4. We have discussed the options for this project with people at the MPCA. They do not encourage or support either technology. The EPA does strongly support the reduction in fossil fuel use, which favors incineration.

The analysis takes into account the revenue from the dried product ($30/ton) and the cost of ash recycling ($53/ton). As you heard at the workshop, there may not be much interest in the dried product at the $30 price. In contrast, we have developed a market for the incinerator ash that is now reducing the cost of ash disposal. Anaerobically digested biosolids are not always very well received and are usually given away free to the farmers and land applied at the sewer rate payer's expense. The dried product market analysis that was done, and is included with the Tech. Memo, shows that every producer of the product had to either dispose of some of the product in a landfill, or sell it at a significantly reduced price.

Farmers in general like the N-Viro soil product. Currently, there is much more demand than supply. I do not have an exact number of farmers that use the product and it changes from year to year depending upon how much is produced and how many acres are involved with each farm. I do not know how farmers evaluate the success of the land application. They seem to like the product and it is a benefit to the fields in which it is applied.

Neither the incinerator ash nor the dried product are an environmental liability. Both residuals meet EPA standards that are designed to protect the public health and the environment.

I believe most of your questions dealing with sustainability were answered in the Workshop that was held on April 28, 1998. We do have some additional material in the response part of the attached package.

You also stated in the Workshop your concern about risks of incineration. EPA's approach to regulating sewage solids, Part 503, was to establish standards for all methods of final processing such that the environmental and health effects would be considered "equivalent". In other words, when implemented, the choice between different methods of wastewater solids processing would have no different effects on the environment or public health. To do this, EPA set a risk threshold for incineration at one cancer per 1,000,000 population and a risk threshold of land application of biosolids at one cancer per 100,000 population. Again the interpretation of this risk approach is to make the choice between wastewater solids processing neutral from an environmental and public health standard not that a higher level of risk was accepted for land application.

Thank you for your interest in the project and if you have any more questions you can call me at 602-8721.

Sincerely,

Allen E. Dye

Allen E. Dye
Project Manager

cc.	Bryce Pickart	Dale Solberg	Jim Brown
	Steve Wareham	Bob Isakson	Trudy Richter
	John Spencer		

May 20, 1998
Mr. John Westley
1747 Blue Bill Drive
Eagan, MN 55122

Re: Response to Questions
Metro Plant Solids Processing Project
MCES Project 970300

Dear Mr. Westley:

The following are responses to your questions submitted to me on April 9, 1998, as part of the public hearing record, and the questions that you faxed to Mark Strohfus of RUST Inc on April 29, 1998. I have also included the package from the public hearing and the workshop that contains the public hearing record and the testimony from the workshop. I apologize for the delay in getting this information to you.

1. The percentage of sludge processed with alkaline stabilization would depend upon incineration "down time" (when incinerators are not available) and when peak loading conditions exist. Peak loading conditions would probably occur only one week out of the year. The down time for incinerators depends upon reliability of equipment and maintenance efforts. We are estimating that each incinerator would be down for a minimum of two weeks each year. Obviously, this will change with the age of the equipment. Therefore, approximately 33% of the solids per day would be processed through alkaline stabilization for at least six weeks of the year or 1.0% of the total year's solids.

2. Cement kiln dust (CKD) has not been used in the N-Viro process for many years. We use lime kiln dust (LKD) which is more reactive than CKD but less reactive than pure lime. Our cost for LKD is about $35 per ton. The cost for CKD is about $16.40 per ton. The dust is used to treat the sludge by raising the ph of the sludge sufficiently for treatment. LKD, although more expensive, is more effective in treating the sludge and therefore requires less to achieve the same end result and the total cost difference is negligible.

3. It would be extremely difficult, if not impossible, to predict what percentage of alkaline stabilized Metro biosolids could be recycled within a 30, 40, 50, and 60 mile radius. It is unlikely however that a land application program that involved alkaline stabilization of 100% of the Metro Plant biosolids would need to exceed a 60-mile radius. The lime in the product provides value to the farmer for up to 10 years. Consequently, repeat applications could be at a frequency of about every five to ten years. The difficulty with a large alkaline stabilized biosolids program is that it would have to compete with other free or low cost lime products such as water treatment lime sludge, industrial wood ashes, coal flue gas desulfurization ash, and CKD.

Thank you for your interest in the project and if you have any more questions you can call me at 602-8721.

Sincerely,

Allen E. Dye

Allen E. Dye
Project Manager

cc.	Bryce Pickart	Dale Solberg	Jim Brown
	Steve Wareham	Bob Isakson	Trudy Richter
	John Spencer	Steve Stark	Mark Strohfus

Metro Solids Processing Project

Facility Plan Public Hearing

RESPONSE DOCUMENT

The Metro Council conducted a public hearing on the Metro Plant Solids Management Facility Plan November 10, 1998. The Facility Plan recommends replacement of the existing multiple hearth incinerators with an energy management alternative consisting of three fluidized bed incinerators (FBI) with supplement alkaline stabilization to handle up to 10%of the plant solids production.

This document summarizes the public testimony and written comments received during the public hearing process and provides an MCES response to those comments.

In summary, there were six issues identified by the public as areas of concern. The six issues are: sustainable development, assumptions used for economic analysis, odors, timing, river front development, and is the project really necessary or can an upgrade of the existing system accomplish the same goals.

The public comments are given first in italics.

Sustainability

The recommended alternative is not sustainable.

The recommended alternative is a sustainable option considering its limited use of fossil fuels, energy conservation, and total emission of metals and air pollutants of concern to the environment.

Sustainable development considers a very broad range of factors. The Minnesota Planning and Environmental Quality Board (EQB) in its document, *Sustainable Development; The Very Idea,* published a set of factors by which sustainable development can be assessed.

The recommended alternative is sustainable because of the following:

1. Lowest use of fossil fuels. Reliance on fossil fuels over the next 20 to 30 years or longer does not meet the EQB's criteria of gradually reducing the reliance on non-renewable energy sources.
2. Lowest emission of greenhouse gases to the atmosphere. The dryer technology use of fossil fuels increases the emission of greenhouse gas over current emissions. The fluid-bed incinerator and alkaline stabilization alternatives will produce nearly the same greenhouse gas emissions as defined by EPA standards.
3. Significantly lower emission of air pollutants of concern than the current multiple hearth incinerators and equivalent levels of emissions as the heat dryer alternative.
4. Total release of heavy metals to the environment is almost equal for all alternatives. However, incineration will capture many of the heavy metals and either bind the metals in cement/concrete construction products or dispose of the heavy metals in an appropriate landfill.
5. The heat value of sewage solids is used for facility heating and plant processes with any excess heat being recycled through co-generation turbine generators to produce electricity for the plant.

Appendix H

The heat value is used entirely in the drying process. Land application alternatives will use the fertilizer value of the sewage solids, but the plant would be required to use additional natural gas to heat all the buildings on the plant site.

6. Lowest cost alternative. The FBI alternative is the lowest cost alternative by approximately $30 million capital cost and $1.0 million annual operating cost.

7. Fewer sources of odors. Odors from the Metro Plant are a continuing concern to the neighbors and surrounding areas in St. Paul. The recommended alternative has fewer sources of odor in the processing of sewage solids. The alkaline stabilization and anaerobic digestion alternatives will have significantly more odor problems.

Economic Assumptions

Comments were received regarding the value of biosolids and the savings it creates for farmers who may use less commercial fertilizer and this savings should be part of the economic analysis.

The economic analysis did account for the offset of fertilizer that may be saved by using biosolids. However, there is no way for the Council to ensure that there would be any reduction in commercial fertilizer use.

Odors

Comments were received that neighbors to the plant have "put up with" the odors from the plant for years and that the FBI alternative provided greater confidence that fewer odor sources would result in less odor problems in their neighborhood.

Odors from the Metro Plant are a continuing concern to the neighbors and surrounding areas in St. Paul. The FBI has no sources of odor and the supplemental alkaline stabilization system is fully contained with treatment of air emissions and odors. The alkaline stabilization system will operate only during peak loads and downtime of the incinerators.

Timing

Comments were received that the project should move forward now to get on with the improvements that will eventually reduce odors to nearby residential areas. Comments were also received that because of the change in state administration, the Council should not move forward with this facility plan.

Implementation of the Metro Solids Processing Improvement Facility plan is part of the Metro Plant overall capital improvement plan. The plan is designed to make those improvements that will allow MCES to meet an increasing demand for wastewater treatment, meet regulatory requirements and most importantly, manage its capital investment program without causing undue rate increases. The Metro Plant Master Plan has determined that the incinerator system will reach the end of its useful life around the year 2005. The MCES, ratepayers, and neighboring communities will benefit from the fluid-bed incineration technology through significantly lower air emissions, reduced odors, streamlined processes, and a reduction in the operation and maintenance costs of the system.

Riverfront Development

Comments were received that incinerators are not what citizens expect as part of riverfront development.

The Metro Plant is located in an I-2 (industrial) zoned area with numerous other industrial areas around the plant. The St. Paul Planning Commission prepared the St. Paul Mississippi River Corridor Plan as part of Critical Area Planning that was adopted by the City in 1981 and was amended in 1987. The Plan recognized the Mississippi River, as a multiple-use corridor comprised of open space, river-related industrial and commercial use, residential mixed use, public facilities and mixed use. The Metro Plant and its continued operation are provided for in this river segment.

The Mississippi National River and Recreation Area (MNRRA) as a unit of the National Park System recognizes that there are river-dependent public uses, such as wastewater treatment, that are appropriate within the MNRRA corridor.

Need for the Project

In the year 2005 the existing incinerators will be 23 years old and will be in need of a major overhaul and upgrade. Installation of a completely new air pollution control train would be warranted and may be required under anticipated new rules be developed by the EPA for sewage sludge incinerators. This will be a considerable cost and installation of new equipment into an existing system that must be kept operational will add additional cost to the construction.

Upgrading the existing system will also mean keeping the multiple-hearth incinerators (MHI) that are much more difficult to operate and maintain. Operation and maintenance efforts and costs would increase with additional equipment and maintaining older equipment.

The U.S. EPA currently anticipates developing new regulations that will put sewage sludge incinerators in a different category that will require significantly better air emissions that are currently required. It will be very difficult and/or very expensive for MHIs to meet these new regulations. The regulations will require that the air emissions be as good as the top 12% of all sewage sludge incinerators.

The Solids Processing Project is a significant step forward in improving the technology of the incineration process that cannot be done by a piecemeal approach of improving only parts of the system with an initial savings in capital cost at the expense of increased operation and maintenance costs. By installing the new technology the Metro Plant and the rate payers will benefit from; improved air emissions from all new air pollution control equipment, streamlined operation and maintenance by reducing the amount of equipment necessary to operate the plant, and operation and maintenance cost savings by having technology that is easier to operate and maintain.

Alternative Delivery Options Technical Memorandum

TO: MCES Metro Solids Processing Improvements Step I Facility Planning Project Core Team (Jim Brown, Allen Dye, Dale Solberg, Steve Wareham)

COPIES: John Spencer/CH2M HILL

FROM: Dave Raby/CH2M HILL

DATE: August 21, 1998

Attached is the Technical Memorandum (TM) summarizing the efforts of the Alternate Delivery Options Task Force on the Metro Solids Processing Improvements project. It recommends that MCES deliver the project using a design/bid/build (DBB) approach coupled with an "Internal Contract" with its staff for operating and maintaining the planned new facilities.

That recommendation is still appropriate, however, in light of recent events that have occurred within MCES, the following further discussion relative to the recommendation is warranted:

1. MCES has recently committed to reducing staff agency-wide as it strives to continue to provide quality services at a competitive price. This commitment, in itself, is effectively an "Internal Contract." Therefore, the agency is essentially espousing use of a similar concept on a widespread basis. Further, because the agency has made this commitment, it may be more appropriate to "Benchmark" on a more widespread basis than that described in the TM.

2. As indicated in the TM, a typical design/build (DB) delivery approach is generally used for relatively straight-forward, un-complicated projects where project requirements can be described without an extensive amount of design effort. For more complex projects, such as the Solids project, a more traditional approach is warranted for the following reasons:

    a. The Solids project is a major, complex facility that must be integrated into the existing Metro plant processes without significant interruptions to normal operations. The Metro plant has been upgraded and expanded numerous times throughout its life and, as is typical at large facilities, it is likely that many of the modifications that have been made have not been well documented on Record Drawings. This can create major problems during construction unless a more complete design effort is performed to locate major pipes, utilities and other obstructions. A Design/Build proposer would include contingencies to protect against these unknowns or otherwise qualify its price proposal.

    b. The Metro plant is the heart of the MCES treatment system in that it processes more than 80 percent of the wastewater generated in the Twin Cities metropolitan area. MCES simply cannot afford to risk a plant shutdown that could be associated with construction problems encountered due to a lack of design detail provided.

    c. As discussed above, MCES is continuing to reduce staff to provide cost-effective service to its ratepayers. To enable staff to efficiently

Appendix I

operate and maintain new facilities in the future, MCES must allow its operations and maintenance staff to provide a significant amount of input into the design and construction of those facilities. This will not only promote a sense of "buy-in" by staff to the efficiencies that must be incorporated into the facilities, but it will allow the agency to take advantage of the wealth of knowledge that exists among its staff relative to how the Solids project can and should be efficiently linked to the remainder of the Metro plant facilities.

d. There is a need to accelerate implementation of portions of the project to effectively deal with the Notice of Violation relative to the emergency stack bypasses on the existing Multiple Hearth Incinerators. It is likely that delivery of some portions of the facilities earlier than others will prevent the agency from spending a significant amount of money to resolve problems associated with facilities that will later be eliminated. These implementation details can be more thoroughly developed in the detail design process.

e. Some of the major components of the Solids project will be pre-selected by MCES and require long lead times for delivery. For example, the centrifuges will be selected based on the results of the on-going demonstration project. In addition, other components will likely require a significant amount of vendor involvement. For example, the Fluidized Bed Incinerators and associated air pollution control systems should likely be designed, fabricated and installed by a single vendor. This extensive amount of "packaging" will require close coordination during design and construction of the entire Solids project that can more easily be controlled with a more traditional delivery approach. However, the packaging of the project should also generate more competition during the bid phase since the packages will be small enough for more contractors (in particular local contractors) to handle. In many respects, the packaging of the incinerator and associated air pollution control components is a Design/Build project within the overall project. It will be more efficient to allow the MCES design/bid/build process manage this procurement rather than a design/build contractor.

f. Because the Solids project is a large, complex project, it will be extremely important to incorporate an extensive amount of constructability knowledge into the design phase of the project to minimize construction change orders (and associated increased costs). MCES employs a cadre of well-qualified construction management staff that has been involved with numerous construction projects at the Metro plant. It will serve the agency well to capitalize on the wealth of knowledge that this staff has gained by allowing them to work closely with the design staff during the design phase of the project.

Metro Solids Processing Improvements Step I Facility Planning Project (MCES Project No. 970300)

Task 6.0, Alternate Delivery Options--Summary

PREPARED FOR: MCES Core Team (Jim Brown, Allen Dye, Dale Solberg, Steve Wareham)

PREPARED BY: Alternate Delivery Options Task Force (Rick Biddle, Denis Gorecki, Dan Greising, Ed LeClair, Reed Santa, Dale Solberg, Steve Wareham, Jason Willett)

COPIES: John Spencer/CH2M HILL

DATE: April 1, 1998

EXECUTIVE SUMMARY

The Metro Project Delivery Task Force (TF) for the Metro Plant Solids Improvements Facility Planning (Metro Plant Solids) Project recommends that the MCES deliver the project using a design/bid/build (DBB) approach coupled with an "Internal Contract" with its staff for operating and maintaining the planned new facilities. Appendix C presents an outline of tasks that the TF identified as being required to accomplish an "Internal Contract".

The TF completed a thorough investigation of the various options for project delivery and a summary of their work is provided below.

TASK SUMMARY

Introduction

As part of the Metro Plant Solids Project, a TF comprised of representatives from various MCES functional workgroups (Metro Plant Operations and Maintenance, Engineering, Construction, Contracts and Finance) was formed to:

1. Identify applicable options for delivering a cost-competitive, technically sound Solids Management Facility for the Metro WWTP, and
2. Evaluate the options identified and recommend the option that best meets stakeholders' (both internal and external) needs.

The following paragraphs summarize the efforts of the TF and the approach taken to ultimately make a recommendation relative to delivery options.

Identification of Delivery Options

The initial task for the TF was to identify various project delivery options that have been (or are now being) used in the industry to deliver large municipal wastewater projects. During early discussions among TF members, it became apparent that they needed to consider options for "complete delivery" of the project over its expected life (i.e. complete project implementation including design, construction and operation and maintenance), as opposed to simply getting it to the point of becoming operational. As a result, the following complete delivery options were identified:

1. Design/Bid/Build (DBB) plus Operation and Maintenance (O&M)

   This is the traditional approach to delivering capital projects that MCES and most other municipal utilities around the country have historically used. It includes design (preparation of contract documents) by an engineering consultant or in-house design staff. Following design, construction bids are solicited and a construction contract is awarded to the lowest responsive, responsible bidder.

   Following construction, the facilities are started up, operated and maintained for their useful life using the owner's operations and maintenance (O&M) staff. However, due to changes in operational approaches occurring in the industry, the TF felt that all of the following O&M approaches should be considered:

   a. MCES Staff O&M—This has been the traditional approach used by MCES and other municipal utilities around the country. All O&M staff are employed by the utility. In most cases, it has served the rate payers well through a process of continuous improvements being made in delivery of O&M services.

   b. Contract O&M—This approach has been used by some municipal utilities in recent years in an attempt to take advantage of organizational efficiencies associated with the private sector. It entails soliciting O&M proposals from the private sector, generally for periods of 5 years or more. Recent changes to IRS regulations do allow for longer contracting periods.

   c. MCES Staff Operations through use of an "Internal Contract"—This approach has been used by a few municipal utilities around the country in recent years to allow municipal employees to guarantee operation and maintenance to be as efficient as the private sector. In fact, MCES is approaching this scenario now with the Business Unit planning that is currently underway at the Metro WWTP. It involves employees identifying various efficiency measures that can be implemented and developing an O&M budget that they agree to not exceed. By doing so, they enter into an "Internal Contract" to not exceed that budget. Examples of various things that can be (and have been) done to improve O&M efficiencies include:

      (1) Implementing a streamlined, value-based procurement process that considers total "life-cycle" costs rather than low bid only.

      (2) Implementing an activity based accounting system to allow accurate tracking of actual costs and to identify potentially excessive cost centers. This provides O&M staff with the cost information they need on a day-to-day basis to allow them to effectively consider costs when making various O&M decisions.

      (3) Standardizing on the use of equipment and materials to allow staff to become more proficient and efficient in operating and maintaining a fewer number of types of equipment and to reduce the level of required spare parts that need to be inventoried.

      (4) Allowing staff to develop a "revenue enhancement" program where they offer services/capabilities to other agencies/organizations.

      (5) Automation of plant operations to reduce O&M costs and to optimize operating efficiencies.

2. Design/Build (DB) plus O&M

   This is an approach to delivering capital projects that MCES and other municipal utilities around the country are beginning to evaluate in an attempt to streamline project delivery and reduce costs. It includes preparation of preliminary engineering/design documents by an engineering consultant or in-house design staff. The extent to which the design is defined in those documents varies with the level of complexity of the project. If a project is relatively simple and straightforward, a limited amount of detail may suffice. However, as projects become more complex (as the Metro Plant Solids Management Facility is likely to be), additional detail must be provided to more completely define the project. **Typically, as a project becomes more complex there are less and less advantages to using the design/build approach.** Following preparation of the preliminary engineering/design documents, proposals are solicited from teams to complete the design and construct the facilities.

   Following construction, the facilities are started up, operated and maintained for their useful life using one of the operating approaches described above for the DBB option.

   Some of the advantages of using the DB delivery option include the potential for streamlined delivery schedules and perceived cost savings. Disadvantages include loss of control of the design and the potential of receiving a lesser quality facility since design details are not totally defined.

   This approach is currently being used by MCES in delivering the Thickening and Dewatering Facilities at the Blue Lake WWTP.

3. Design/Build/O&M (DBO)

   This is an approach to delivering capital projects that MCES and other municipal utilities around the country are also beginning to evaluate in an attempt to streamline project delivery and reduce costs. It can include preparation of either performance standards or preliminary engineering/design documents by an engineering consultant or in-house design staff. Following preparation of the performance standards or preliminary engineering/design documents, proposals are solicited from private sector teams to complete the design, construct the facilities, start them up and operate and maintain them for an initial period (usually 3 to 5 years at a minimum). The teams are usually comprised of a design firm, an operations firm and a construction contractor. Adding O&M to the Design/Build approach is one way to assure that the bidding team does not compromise the design of facilities (since they will be responsible for keeping the facilities operational for an initial period and potentially up to 20 years through a series of 3 to 5 year contract extensions). Using this approach, the utility retains ownership of the facilities and can use tax exempt financing. In addition, they can either continue to contract out the O&M in the future or use their own staff.

   This approach (with preparation of performance standards) is currently being used by MCES in delivering the Final Stabilization Facilities at the Blue Lake WWTP.

4. Design/Build/Own/O&M (DBOO)

   This approach to delivering capital projects also attempts to streamline project delivery and reduce costs. Like DBO, it can include preparation of either performance standards or preliminary engineering/design documents by an engineering consultant or in-house design staff. Again, following preparation of the performance standards or preliminary engineering/design documents, proposals are solicited from teams to complete the design, finance and construct the facilities, start them up and own, operate and maintain them for an extended period (usually up to 20 years). Usually the financing is secured by the private delivery teams. Using this approach, the utility simply pays a fee to the private team based on the services provided. Following the contract period, the utility usually has the option of either extending the contract or taking ownership of the facilities and operating and maintaining them with their own staff.

Evaluation of Delivery Options

Evaluation Criteria

In a series of meetings, TF members began the process of evaluating the various delivery options identified above. As a first step, they developed a list of fourteen (14) criteria that they felt would be important for considering each of the options. The criteria identified are briefly described below:

1. Costs—Total costs associated with the project including initial capital and operations & maintenance (O&M) costs over the life of the facility (life-cycle costs).
2. Schedule—Total time to deliver the project from the initiation of design through performance testing and start-up of all facilities.
3. Risk of Performance Failure/Default—Potential for a specific delivery approach to result in poor or unacceptable performance and ultimate failure.
4. Risk of Unanticipated Financial Loss to MCES—Potential for MCES to have to invest more in capital and/or O&M over the life of the facility than originally anticipated.
5. Safety/Health Risks (to MCES staff and the public)—Potential risks associated with either fewer health and safety issues being considered during design, construction and operations of the facility or a lack of safety consciousness of key participants.
6. Risks Associated with MCES' Ability to Deal with Changes—Potential risks associated with addressing changes initiated by MCES during any phase of the project.
7. Operational Control—Potential impacts on other MCES facilities or processes due to MCES' inability to control operations at the new facility.
8. Constructed Quality of the Facility—Overall quality of equipment and materials and how they are incorporated into the facility that may impact long-term costs and ability to efficiently operate and maintain it.
9. Innovation (in Selecting Technology)—Perceptions associated with the ability to consider new ideas in an attempt to reduce costs versus incorporating too much conservatism (and the perceived cost associated with doing so) into the technology selection process.
10. Project Flexibility—The ability to deal with changes caused by external factors (such as needing to process more solids) throughout all phases of the project by being able to make decisions quickly and having procedures in place to allow efficient response.
11. Ability to Obtain Permits—Ease of dealing with regulatory agencies in obtaining required permits for the facility associated with either their familiarity (or lack thereof) with the delivery approach and/or their history of dealing with project participants.

12. HR Impacts (to MCES staff)—Overall impacts to MCES staff associated with either having to change the way they have historically provided services or loss of job opportunities.
13. MCES Debt Capacity—Potential impacts to MCES associated with their having to finance and own the facility (by using a portion of their bonding capacity) versus being able to effectively "lease" the facility and use bonding capacity to fund other needs.
14. Ability to Deal with Metro WWTP and System-Wide Requirements—Ease of interfacing with other Metro WWTP treatment processes and/or other MCES facilities to meet potential changing needs of those processes or facilities.

Ranking of Options

Once the evaluation criteria were identified, each criterion was discussed by the TF members to develop a consensus opinion, on a scale of one (1) to five (5), with 1 being worst and 5 being best, of how each of the delivery options being evaluated met that specific criterion.

In addition, each criterion was weighted relative to its perceived importance in the decision making process for the Metro Plant Solids Handling Facilities. Initially, the TF attempted to weight the criteria on a scale of one (1) to five (5). However, it became apparent that using such a small range for fourteen (14) criteria did not allow significant differentiation of importance of one criterion over another. Therefore, the TF chose to assign weights using the following approach:

1. Assign a total of 100 points to all criteria that should be considered in the evaluation. The more points assigned to a given criterion reflects a higher level of importance being placed on that criterion in the decision making process.
2. To prevent a single criterion from overwhelmingly controlling the decision making process, no more than 40 points was assigned to a single criterion.

As a result of the above effort, the matrix included in Appendix A was developed.

Outside Input

The TF discussed the evaluation process and decided that it could benefit from outside (i.e. non-MCES staff) input. Therefore, it was agreed that MCES should host a workshop where representatives of other large municipal agencies from around the country would be asked to describe their efforts in delivering, or attempting to deliver, large municipal projects using some of the non-traditional delivery approaches being considered by MCES. Such a workshop was held on October 24, 1997. Participants included representatives from agencies in Boston, MA; New York City, NY; Louisville, KY; San Diego, CA; and Seattle, WA. A summary of that workshop is included in Appendix B.

In addition, as part of its on-going communications effort, the Solids Core Team conducted a workshop with the Environment Committee on January 6, 1998. Among the topics discussed at that workshop was the project delivery option evaluation process. Environment Committee members were given a brief overview of the process and asked to send comments relative to the importance of each of the criteria identified for evaluating project delivery options to the Core Team. Following the workshop, two of the members did submit comments indicating general concurrence with the weighting system developed and used by the TF. It was apparent that some of the criteria (e.g. Risk Associated with Dealing With Changes, Operational Control, Innovation, Risk of Unanticipated Financial Loss, Project Flexibility, MCES Debt Capacity and Ability to Deal with Metro WWTP and System-Wide

Requirements) were consistently rated as relatively unimportant by the TF as well as both Environment Committee members.

Conclusions

Following the workshops with other agency staff and the Environment Committee, the TF met again and reached the following conclusions:

1. Ownership of Facilities. In discussions with representatives from other agencies, several common threads appeared relative to when private ownership of facilities should be considered. They include:

    a. When an agency has no site of its own available for facilities.

    b. When an agency has no prior experience with a specific treatment function or technology.

    c. When an agency has an unusually short amount of time available to implement a project.

    d. When an agency has a problem relative to being able to fund a project within its current bonding limits.

    In addition, preliminary results from MCES' first attempt to compare the financial benefits of public ownership versus private ownership at the Blue Lake WWTP indicate that costs of public ownership are significantly less than costs of private ownership; due in that case, primarily to the much lower borrowing costs for public agencies such as MCES.

    Therefore, the private ownership delivery option that was evaluated (DBOO) by the TF will not create net advantages for MCES.

    There are ways to utilize tax exempt financing with the DBOO option that could make that more attractive to MCES on other projects. Use of such financing should be considered on a case-by-case basis.

2. Operation of Facilities. The first of three (3) operations options described above (MCES Staff Operations) should no longer be considered. Two (2) operations options should be considered: Contract Operation (by a private entity) or Internal Contracting (by MCES staff), which is the logical next step in business unit planning already occurring at the Metro Plant.

Recommendation

Upon review of both outside input and the internal evaluation, the TF believes that the most advantageous delivery option for MCES on the Metro Plant Solids Handling Project would likely be the traditional DBB approach coupled with development of an Internal Contract for operations and maintenance by MCES staff.

Therefore, the TF recommends that MCES begin the process of developing an Internal Contract by embarking upon an operations and maintenance benchmarking process concurrently with completion of the Facilities Plan. It should be noted that taking this approach now, always allows Council to have the flexibility to revert to a Contract Operations scenario at any time before accepting the Internal Contract from staff. The preliminary approach to this process that they recommend is described in Appendix C.

Another delivery approach that would likely offer some advantages is DBO. DBO is recommended as the alternate to DBB instead of DB since it is felt that requiring the design builder to operate and maintain the facilities in compliance with a set of performance standards for a period of time would help ensure delivery of better quality facilities. However, to effectively implement the project in a timely manner, once the preliminary design is complete, a final decision must be made whether to proceed with final design (and the DBB approach) or preparation of an RFP for delivery using a DBO approach.

Appendix B

Project Delivery Workshop

Metro WWTP Solids Processing Improvements

Objective: Obtain input from other municipal agencies relative to their experiences with alternate project delivery approaches used for large municipal projects to assist MCES in evaluating delivery options for the Metro WWTP Solids Processing Improvements project.

Location: Metro WWTP, West Screen and Grit, Room 103

Date/Time: Friday, October 24, 1997/9:00 a.m. - 3:00 p.m.

Participants in the October 24 Workshop (and key messages) included:

- Gordon Garner/Executive Director of the Louisville and Jefferson County (Kentucky) Metropolitan Sewer District (MSD)—
    1. Project Description—Solids Handling [150 dry tons per day (dtpd)], on site at the MSD's largest WWTP using any technology and either DBO or DBOO delivery approaches.
    2. Project Drivers—MSD's limited bonding capacity and an MSD policy decision to test competitive initiatives.
    3. Issues Identified—Different risk postures (e.g. MSD's risk "avoidance" posture vs. private entities' risk "management" posture), costs, staff (MSD encouraged use of their staff but did not mandate it), and permitting (MSD believes they will likely be involved with the project permits).
    4. Status—After a year of unsuccessful negotiations, they have ceased negotiations and are going to re-issue an RFP requiring use of Anaerobic Digestion technology and allowing only DBOO proposals.
- Al Lopez/Deputy Director of the New York City Department of Environmental Protection—
    1. Project Description—Solids Handling (300 dtpd), off site using any technology and only a DBOO delivery approach.
    2. Project Drivers—No prior agency experience in handling wastewater solids (had been ocean dumping), court ordered schedule, no agency site available. Agency was seeking a diversity of end uses and received a variety of proposals that were screened to those proposals with proven performance.
    3. Issues Identified—Although safety, vendor response, operations interface and permitting were concerns, they didn't end up creating any problems. Therefor, although the agency had planned the project as an interim step, they have implemented it as a permanent solution.
    4. Status—The first projects have been operational for a number of years and the agency is beginning to re-negotiate agreements to allow the projects to continue.
- Rick Mills/Director of Residuals Management for the (Boston) Massachusetts Water Resources Authority—
    1. Project Description—Solids Handling (140 dtpd), dryer, on an agency owned site, using a DBO approach. Private operator provided design. Agency used traditional DBB to construct. Private operator operates facility.
    2. Project Drivers—No prior agency experience in handling wastewater solids (had been ocean dumping), court ordered schedule.

3. Issues Identified—Although design and construction quality were concerns, they didn't end up causing problems. Because the agency has the option to have the private company operate the facility for as long as the agency wants, they believe it in their best interest to be flexible during negotiations and to require detailed documentation of all costs. The agency believes that they should always retain ownership of facilities constructed on their site.
4. Status—The first project has been operational for a number of years and the agency is beginning to re-negotiate agreements to reduce costs yet allow the project to continue

- David Schlesinger/Director of the San Diego Metropolitan Wastewater Department—Mr. Schlesinger discussed a co-generation project that was not directly applicable to the Metro Solids Project.
- John Spencer/CH2M HILL (formerly Director of the Seattle Metro Wastewater Agency)-
  1. Project Description—Solids Handling on an agency owned site using a DBOO option only.
  2. Project Drivers—The desire to eliminate politically undesirable anaerobic digesters. Limited space on a shoreline environment led to community interest in removing digesters.
  3. Issues Identified—Technology should be selected prior to requesting proposals. Contractual terms should be included with RFP. Staff should be involved in developing the project so that in the event they need to step in and take over operations, they will be prepared to do so.
  4. Status—After several years of operation, the agency has terminated its contract with the private entity for failure to meet performance standards. King County Metro has negotiated to purchase the facility (since it is located on the agency's site). Upgrade of the facility is now under design. Many technology improvements as well as OSHA improvements are needed. A concern remains that agency staff will not agree to operate the facility because of safety reasons. Currently, solids are being digested, dewatered and land applied in a successful forestry and agriculture program.

Appendix C

Benchmarking/Internal Contracting

(4/1/98)

Definitions

"Benchmarking"

The TF has defined "Benchmarking" as an investigation of comparable facilities to identify best practices and determine direct, controllable costs associated with operating and maintaining those facilities. Direct controllable costs could include labor, materials, and utilities. From the data obtained during this investigation, a competitive cost for operating and maintaining the Metro Plant Solids Project will be established.

"Internal Contract"

The TF has defined an "Internal Contract" as an agreement, that may be in the form of a Memorandum Of Understanding (MOU), between MCES employees and the Council to provide competitively priced operations and maintenance services for the Metro Plant Solids Project. The operations and maintenance staff will "benchmark" comparable facilities, both publicly and privately operated, in order to define labor and materials costs that are competitive.

Tasks

1. TEAMING UP: Between now and November '98 (after the final decision relative to technology is made), identify and establish a benchmarking team who will be charged with defining the services to be benchmarked [and ultimately included in the Internal Contract (IC)] and collecting comparable data from other installations. Ideally, the benchmarking team should include representatives of MCES' engineering, operations, maintenance, and Office of Business Planning (OBP) groups plus appropriate consultant support that would work to define the services that will be provided in operating and maintaining the Metro Solids facilities and help to finalize a plan for developing the IC.
2. CONTRACTING EXAMPLES: Identify (one or two) agencies who have succeeded in implementing an IC and have the benchmarking team (or representatives of the team) talk to/meet with representatives of the respective IC teams to discuss their approaches to developing their ICs. Likely candidates may include San Diego, Charlotte, Miami-Dade, et.al. Following these discussions/meetings, refine our plan as may be necessary and develop a summary of how these other agencies succeeded in implementing an IC and, based on what we learned from those agencies, how we are proposing to implement a similar approach. Use this summary information to develop a memorandum of understanding (MOU) which includes a commitment to develop an IC. Complete this task and submit the MOU for approval by the Council in early '99.
3. PRELIMINARY STAFFING ASSESSMENT: Concurrent with Task 2, identify 10 to 15 large (as close in size to Metro as possible) installations using the selected technology for use in the benchmarking process. A preliminary list of installations has already been prepared. We will attempt to find installations that are operated by both public agencies and private contractors.

Once we identify them, we will obtain preliminary benchmarking data from them [e.g. Total O&M Cost/dry ton (dt), Total O&M Staff members/dt, et.al.] In addition, information from the Water Environment Federation's benchmarking efforts in the last few years will be obtained. Using this preliminary information, we will identify up to 5 specific installations that warrant further investigation. This information, along with that obtained in Task 2 above, will be used to prepare the MOU for approval by the Met Council in early '99.

4. FORMAL BENCHMARKING: If the concept is acceptable to the Council (Tasks 2 and 3 above), the benchmarking team will develop a list of questions and/or information to be requested from the selected installations. Ideally, the benchmarking team (or representatives, thereof) will visit those installations and meet with representatives of their respective IC teams to ask the questions and obtain/review the information. This should be completed between January and March '99.

5. INTERNAL CONTRACT DEVELOPMENT: While the benchmarking team is collecting data, an IC team (with representation from the benchmarking team) will be established to take the information obtained by the benchmarking team and to develop the terms and conditions for an IC for providing services. Ideally, the IC team should include representatives from MCES' senior management, engineering, operations, maintenance, OBP, Managed Competition, procurement/purchasing, finance and contracts groups. Between March and June '99 while the 30% design is being prepared, using the information obtained/knowledge of O&M requirements gained, the IC team will prepare a preliminary IC outlining specific goals (e.g. numbers of O&M staff required, total O&M costs, etc.) plus a preliminary list of Terms and Conditions that they believe must be met to enable Council staff to commit to an IC. Once the 30% design is complete in June '99, the IC team will present the preliminary IC to the Council for approval. The goal will be to complete the final IC while either the final design is being completed using a DBB delivery approach or facilities are being delivered using a DB approach. The final IC will be presented to the Council for approval in June 2000.

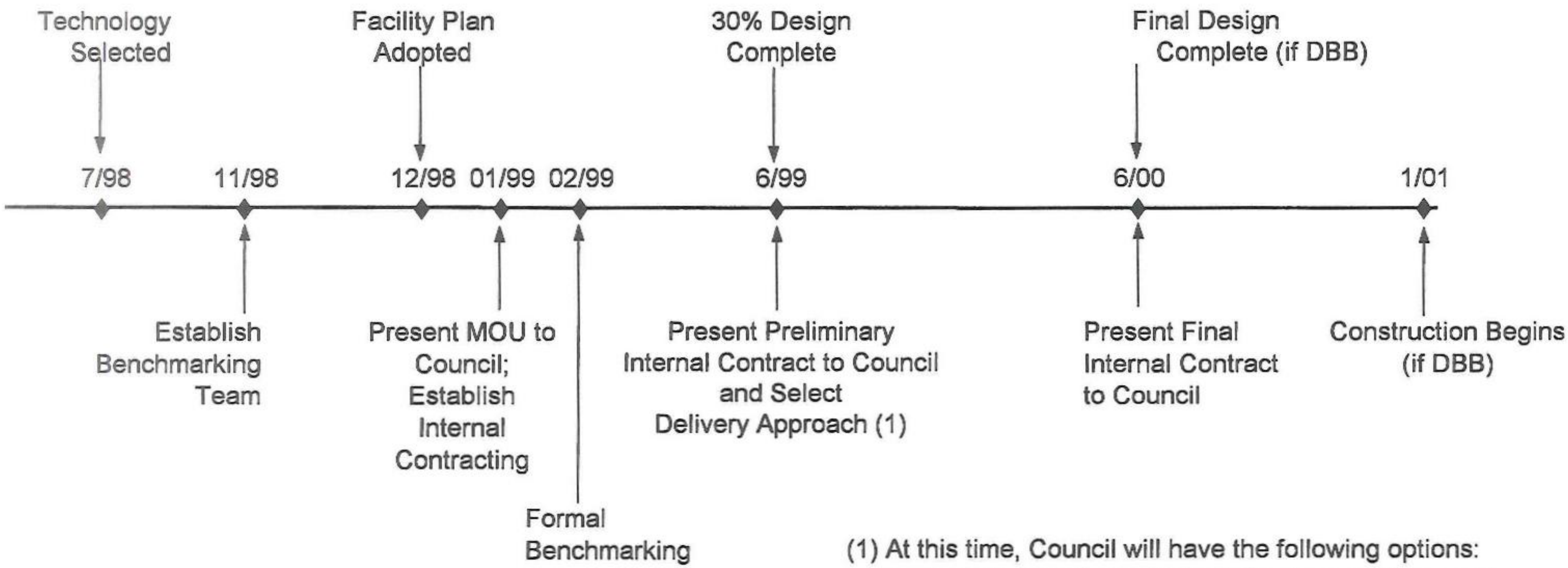
A timeline showing how these activities mesh with the overall project is attached.

Appendix A

METRO SOLIDS PROCESSING PROJECT
PROJECT DELIVERY ANALYSIS

Average wieghting Scale of 100 pts (1)	26.5	6.1	9.6	4.3	9.6	4.1	4.5	6.3	1.5	2.5	6.6	11.8	1.5	5.1	
Project Delivery Approach	**Costs (capital, operations, life-cycle, rates)**	**Schedule**	**Risk of Performance Failure/Default**	**Risk of Unanticipated Financial Loss to MCES**	**Safety/Health Risks (to Staff and Public)**	**Risks Associated with MCES' Ability to Deal with Changes**	**Operational Control**	**Constructed Quality of Facility**	**Innovation (in selecting technology)**	**Project Flexibility**	**Ability to Obtain Permits**	**HR Impacts (to MCES staff)**	**MCES Debt Capacity**	**Ability to Deal with Metro WWTP and Sytem-Wide Requiremnts**	**Total Score (4)**
D/B/B with MCES Operations	Perception is that this approach is more costly than others since there are separate and distinct design and construction periods and few incentives for employees to operate efficiently.	By having separate design and construction phases, the schdule is longer.	Since MCES has total control and no history of failure relative to performance of its plants, there is little risk.	Since MCES will be responsible for making any changes required, all financial risks are borne by them.	Both internal and external risks are low.	Few risks since this is a traditional approach with MCES control.	Total operational control by MCES staff.	MCES completely controls quality by specifying design requirements.	Perception is that there is less opportunity for innovation.	Approach may offer more flexibility to make changes since MCES has the most overall control, however, internal processes relative to implementing changes is cumbersome.	It should be easier to obtain permits since this approach is well understood by agencies, however, MCEs may have "baggage" from past dealings.	This approach would have the least number of internal impacts.	MCES must pay for the capital cost of the facility using PFA loan or bond proceeds.	It is easier to interface with other Metro systems if MCES controls the operations of all facilities.	
Rank 1 - 5 (2)	2	2	5	2	5	5	5	4	2	3	3	5	3	5	
Score (3)	53.0	12.2	48.0	8.6	48.0	20.5	22.5	25.2	3.0	7.5	19.8	59.0	4.5	25.5	357.3
D/B/B with Contract Operations	By providing competition, operations cost should be reduced.	By having separate design and construction phases, the schdule is longer.	Since a private entity has control of operations, there could be more risk of failure.	Since the private entity would be responsible for operational changes, the risk is less to MCES.	Risks could be slightly higher since a private entity is now involved and may not be as safety conscious as MCES.	More operational risks associated with loss of control.	Less control by MCES relative to impacts to its overall system.	MCES completely controls quality by specifying design requirements.	Perception is that there is less opportunity for innovation.	Operational changes would involve negotiations with a private entity.	It should be easier to obtain permits since this approach is well understood by agencies, however, MCEs may have "baggage" from past dealings.	There would be numerous internal impacts associated with loss of MCES jobs.	MCES must pay for the capital cost of the facility using PFA loan or bond proceeds.	Having a private entity operating would make it more difficult to interface with other Metro systems.	
Rank 1 - 5 (2)	4	2	4	3	4	4	2	4	2	2	3	2	3	3	
Score (3)	106.0	12.2	38.4	12.9	38.4	16.4	9.0	25.2	3.0	5.0	19.8	23.6	4.5	15.3	329.7
D/B/B with MCES Efficiency Goals	By implementing efficiency goals, operations cost should be reduced.	By having separate design and construction phases, the schdule is longer.	Since MCES has total control and no history of failure relative to performance of its plants, there is little risk.	Since MCES responsible for making changes, and will be forced to take more chances to become more efficient, there is potential increased financial risks.	Both internal and external risks are low.	Few risks since this is a traditional approach with MCES control.	Total operational control by MCES staff, however, implementing efficiency measures could reduce control.	MCES completely controls quality by specifying design requirements.	Perception is that there is less opportunity for innovation.	Approach may offer more flexibility to make changes since MCES has the most overall control, however, internal processes relative to implementing changes is cumbersome.	It should be easier to obtain permits since this approach is well understood by agencies, however, MCEs may have "baggage" from past dealings.	There would likely be numerous internal impacts associated with implementing efficiency goals.	MCES must pay for the capital cost of the facility using PFA loan or bond proceeds.	Easier to interface with other Metro systems if MCES controls the operations of all facilities, however, the efficiency goals could make it somewhat more difficult.	
Rank 1 - 5 (2)	4	2	5	1	5	5	4	4	2	3	3	3	3	4	
Score (3)	106.0	12.2	48.0	4.3	48.0	20.5	18.0	25.2	3.0	7.5	19.8	35.4	4.5	20.4	372.8
D/B Proposal with MCES Operations	Industry-wide perception is that this approach is costly since there are few employee incentives to operate efficiently.	By combining the design and construciton phases, the schedule is shortened, however, negotiating the contract will take time.	Since MCES has less control over design/construction, risks are increased.	Since MCES will be responsible for operational changes, design detail was limited and costs were primary selection criteria; risks are likely higher.	Risks could be somewhat higher since less design detail is provided .	Risks could be somewhat higher since less design detail is provided.	Total operational control by MCES staff.	Less quality than traditional since not completely designed by MCES, however, costs are not the driving factor.	Perception is that there is more opportunity for innovation during the design phase.	more flexibility to make changes since MCES has the most overall control, however, internal processes relative to implementing changes is cumbersome.	Should be relatively easy to obtain permits since D/B is becoming more understood by agencies, however, MCES may have "baggage" from past dealings.	This approach would have the least number of internal impacts associated with operations.	MCES must still pay for the capital costs but may not finance it up front.	It is easier to interface with other Metro systems if MCES controls the operations of all facilities.	
Rank 1 - 5 (2)	2	3	3	1	4	4	5	2	3	3	3	5	3	5	
Score (3)	53.0	18.3	28.8	4.3	38.4	16.4	22.5	12.6	4.5	7.5	19.8	59.0	4.5	25.5	315.1
D/B Proposal with Contract Operations	By providing competition, operations cost should be reduced.	By combining the design and construciton phases, the schedule is shortened, however, negotiating the contract will take time.	Since MCES has less control over design/construction and no control over operations, risks are increased.	Since a private entity will be responsible for some operational changes, risks are likely slightly lower.	Risks are likely increased with MCES' loss of operational control.	Risks are likely higher due to loss of operational control.	Less control by MCES relative to impacts to its overall system.	Less quality than traditional since not completely designed by MCES, however, costs are not the driving factor.	Perception is that there is more opportunity for innovation during the design phase.	Operational changes would involve negotiations with a private entity.	Should be relatively easy to obtain permits since D/B is becoming more understood by agencies, however, MCES may have "baggage" from past dealings.	There would be numerous internal impacts associated with the loss of MCES operations jobs.	MCES must still pay for the capital costs but may not finance it up front.	Having a private entity operating would make it more difficult to interface with other Metro systems.	
Rank 1 - 5 (2)	4	3	2	2	3	3	2	2	3	2	3	2	3	3	
Score (3)	106.0	18.3	19.2	8.6	28.8	12.3	9.0	12.6	4.5	5.0	19.8	23.6	4.5	15.3	287.5
D/B Proposal with MCES Efficiency Goals	By implementing efficiency goals, operations cost should be reduced.	By combining the design and construciton phases, the schedule is shortened, however, negotiating the contract will take time.	Since MCES has less control over design/construction and will make efficiency changes, risks are increased.	Since MCES resp for oper changes, design detail was limited, costs were primary selection criteria and MCES will make efficiency changes; risks are likely higher.	Risks could be somewhat higher since less design detail is provided and efficiency changes are implemented.	Risks could be somewhat higher since less design detail is provided and efficiency changes are implemented.	Total operational control by MCES staff, however, implementing efficiency measures could reduce control.	Less quality than traditional since not completely designed by MCES, however, costs are not the driving factor.	Perception is that there is more opportunity for innovation during the design phase.	Approach may offer more flexibility to make changes since MCES has the most overall control, however, internal processes relative to implementing changes is cumbersome.	Should be relatively easy to obtain permits since D/B is becoming more understood by agencies, however, MCES may have "baggage" from past dealings.	There would likely be numerous internal impacts associated with implementing efficiency goals.	MCES must still pay for the capital costs but may not finance it up front.	It is easier to interface with other Metro systems if MCES controls the operations of all facilities, however, implementing efficiency goals could make it somewhat more difficult.	
Rank 1 - 5 (2)	4	3	2	1	4	4	4	2	3	3	3	3	3	4	
Score (3)	106.0	18.3	19.2	4.3	38.4	16.4	18.0	12.6	4.5	7.5	19.8	35.4	4.5	20.4	325.3
DBO	Design, construction and operations costs can be reduced by introducing competition while utilizing the public sector's lower cost of money.	Any time saved in combining the design and construction phases may be lost in preparing for/negotiating agreements.	There is more risk of default than with a traditional approach, however, private entities must perform to stay in business.	Because MCES owns the facilities, there is some risk associated with financial losses.	Risks are likely higher due to loss of operational control.	Risks are likely higher due to loss of operational control.	Less control since operated by a private entity for a minimum of 3 to 5 years.	quality is expected due to the need for private entities to be competitive in constructing facilities, yet be responsible for performing for up to 20 years.	Perception is that there is more opportunity for innovation overall, however, with public ownership, the tendency toward conservatism may still exist	This approach requires negotiations with a third party for all changes, however, with public ownership changes can be made.	Should be relatively easy to obtain permits since D/B is becoming more understood by agencies, however, MCES may have "baggage" from past dealings.	There likely would be numerous impacts associated with MCES design and construction staff responsibility changes as well as loss of operational jobs.	MCES must still pay for the capital costs but may not finance it up front.	Having a private entity operating would make it more difficult to interface with other Metro systems.	
Rank 1 - 5 (2)	5	3	4	3	3	3	2	3	4	3	3	1	3	3	
Score (3)	132.5	18.3	38.4	12.9	28.8	12.3	9.0	18.9	6.0	7.5	19.8	11.8	4.5	15.3	336.0
DBOO	Design, construction and operations costs can be reduced by introducing competition. However, private sector cost of money is likely higher.	Any time saved in combining the design and construction phases may be lost in preparing for/negotiating agreements.	There is more risk of default than with a traditional approach, however, private entities must perform to stay in business.	Because MCES simply pays a users fee, if there is a loss, there is the least amount of risk for MCES.	Risks are likely higher due to loss of operational control.	Risks are likely the highest since any change during any phase will require negotiation.	Even less control since operated by a private entity for up to 20 years.	An average level of quality is expected due to the need for private entities to be competitive in constructing facilities, yet be responsible for performing for up to 20 years.	Overall, the perception is that this approach offers the most opportunity for innovation.	This approach likely offers the most flexibility since the private entity can make changes at will and has fewer internal processes to deal with.	This approach (ie. private entity ownership) is less common, therefore, it may be harder for agencies to deal with. However, the private entity likely would not have any "baggage".	There likely would be numerous impacts associated with MCES design and construction staff responsibility changes as well as loss of operational jobs.	MCES pays an annual service fee using operating funds and is able to use it's less costly PFA funds for other projects.	Having a private entity operating, as well as owning, a facility would make it the most difficult to interface with other Metro systems.	
Rank 1 - 5 (2)	4	3	4	5	3	1	1	3	5	4	3	1	5	2	
Score (3)	106.0	18.3	38.4	21.5	28.8	4.1	4.5	18.9	7.5	10.0	19.8	11.8	7.5	10.2	307.3

(1) Averae Weighting--A total of 100 points assigned to criteria on a basis of relative importance of that criteria.
(2) Rank--Scale of 1 to 5, with 5 being the best, of how each delivery option meets a given criterion.
(3) Score--Overall score for a given delivery option computed by multiplying the Average Weighting for each criterion times the Rank assigned to that criterion for a given delivery option.
(4) Total Score--For each delivery option computed by adding all criterion scores for that delivery option. Higher Total Scores indicate that a delivery option is more likely better for meeting MCES' needs on the Metro Solids Handling Project.



(1) At this time, Council will have the following options:

a. Accept preliminary Internal Contract and proceed with either the DBB or DB delivery approach.

b. Reject the preliminary Internal Contract and proceed with the DBB or DB delivery approach (along with Contract Operations).

At all times, Council will have the option of reverting to a Contract Operations option.

Appendix J
ACRONYMS, ABBREVIATIONS and UNITS OF MEASURE

BOD = biochemical oxygen demand
CFR = Code of Federal Regulations
CIP = capital improvement program
CO = carbon monoxide
CO_2 = carbon dioxide
COD = chemical oxygen demand
Council = Metropolitan Council
DAF = dissolved air flotation
DB = Design/Build
DBB = Design/Bid/Build
DBOO = Design/Build/Own/O&M
Dia = diameter
EAW = Environmental Assessment Worksheet
EIS = Environmental Impact Statement
EIW = Environmental Information Worksheet
EPR = East Primary
ESP = electrostatic precipitator
FAA = Federal Aviation Administration
FBI = fluid bed incinerator
FTE = full-time equivalent employee
H_2S = hydrogen sulfide
H_2SO_4 = sulfuric acid
HAP = hazardous air pollutant
HC1 = Hydrogen chloride
HRT = hydraulic retention time
HVAC = heating, ventilation, and air conditioning
ID = induced draft
M = Million
MAC = Metropolitan Airport Commission
MCES = Metropolitan Council Environmental Services
MDS = Metropolitan Disposal System
MHF = multiple hearth furnace
MHI = multiple hearth incinerator
MP = Master Plan
MPCA = Minnesota Pollution Control Association
MS = Minnesota Statute
MWWTP = Metropolitan Wastewater Treatment Plant
NAAQS = National Ambient Air Quality Standards
NESHAP = National Emission Standards for Hazardous Air Pollutants
NH_3-N = ammonia
NO_x = nitrogen oxides
NPDES = National Pollutant Discharge Elimination System
NPS = National Park Service
NSPS = new source performance standards
NSR = New Source Review
O&M = Operations and Maintenance
PCB = polychlorinated biphenol
PCDD = Polychlorinated di-benzo dioxin
PCDF = Polychlorinated di-benzo furan
PFA = Public Facilities Authority
PM = particulate matter

PM_{10} = particulate matter less than 10 microns diameter
POTW = publicly-owned treatment works
PSD = Prevention of Significant Deterioration
PTE = potential to emit
RBS = rotating biological surface
RGU = Responsible Governmental Unit
RTO = regenerative thermal oxidizer
SAC = service availability charge
SHPO = State Historical Preservation Office
SO_2 = sulfur dioxide
SO_x = sulfur oxides
THC = total hydrocarbons
TKN = total Kjeldahl nitrogen
TP = total phosphorous
TSS = total suspended solids
USEPA = Unites States Environmental Protection Agency
VIS = venturi/impingement scrubber
VOC = volatile organic compound
VP = VenturiPak
WAS = waste activated solids
WESP = wet electrostatic precipitator
WHB = waste heat boiler
WPR = West Primary
WSG = West Screen and Grit
WWTP = wastewater treatment plant

Units of Measure

ac/hr = air changes per hour
acfm = actual cubic feet per minute
BTU = British Thermal Units
cf = cubic feet
cfm = cubic feet per minute
dscf = dry standard cubic feet
dt = dry tons
dt/d = dry tons per day
dtpd = dry tons per day
ft = feet
ft/sec = feet per second
gal = gallons
gpm = gallons per minute
hr = hour
kV = kilovolt
kW = Kilowatt
lb = pounds
lbs/dt = pounds per dry ton
mg/L = milligrams per liter
mgd = million gallons per day
μm = micron
no. = number
psi = pounds per square inch
psig = pounds per square inch gage
scfm = standard cubic feet per minute
tons/hr = tons per hour
tpy = tons per year
wt = wet tons